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DISTRIBUTION AND ACOUSTIC BACKSCATTER OF HERRING IN NAFO DIVISIONS 4T AND 4Vn, OCTOBER 1993

by

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ABSTRACT

The 1993 fall distribution and acoustic backscatter of herring in NAFO Divisions 4T and 4Vn indicates that the East Miscou area was the main area of concentration for herring in October, with 75% of the total backscatter recorded. The highest concentrations found in Chaleur Bay were in the eastern portion, with 12% of total backscatter, while the Cape Breton area accounted for 9%. The total backscatter and biomass estimates for 1993 are lower than 1992. Transceiver malfunction resulted in the lost of 30% coverage in the Chaleur Bay area. The overall percentage length of transect with backscatter recorded was the lowest (7.5%) of the past four years. However, the Chaleur offshore area, which includes the East Miscou strata, had the highest proportion of transects with backscatter recorded in 1993. Mostly adult herring were found in sets both in Chaleur Bay and the Cape Breton area, some juvenile herring were found in the West Miscou strata set. The Chaleur Bay samples were composed of 63% fall spawners while the Cape Breton area had 92% fall spawners. The fall spawners represented 65% of the 1993 total backscatter detected (4T plus 4Vn), the dominant year-class being 1987, as 6 year-olds. For the spring spawners, the strongest year-class was 1991 which accounted for 65% of the 1993 spring spawners. A total of 73 CTD profiles were taken during the 1993 survey. Temperatures in all areas and depth ranges varied between -0.5 and 13 °C, while the salinity ranged from 28.0 to 34.0. The East Miscou area had the widest temperature range with a well defined thermocline. No acoustic backscatter was detected in eastern Cape Breton (4Vn) nor southwestern Newfoundland (3Pn) during a January 1994 winter acoustic survey.

RESUME

La distribution géographique et la difusion acoustique des bancs de harengs détectés durant le relevé acoustique de 1993, dans les divisions 4T et 4Vn de l'OPANO, indiquent que la strate Miscou est de la baie des Chaleurs était la principale région de concentration du hareng en octobre, responsable pour 75% du total de la difusion acoustique. La plupart des autres concentrations de hareng furent détectées dans le secteur est la baie des Chaleurs avec 12% du total de la difusion acoustique, et la région du Cap Breton avec 9%. Un bris de la sondeuse acoustique résultat dans une perte de 30% de l'air de recensement planifié dans la baie des Chaleurs. L'estimation de la biomasse d'après l'intensité de la difusion acoustique est inférieure à 1992. Le pourcentage de la distance totale couverte sur laquelle il y avait de la difusion acoustique présente était à son plus bas niveau (7.5%) depuis quatre ans. Cependant, la zone de la baie des Chaleurs qui inclue la strate de Miscou contenait la plus grande proportion de transects avec de la difusion acoustique détectée en 1993. Des harengs adultes dominaient les prises dans les échantillons de la baie des Chaleurs et du Cap Breton, l'exception étant la strate Miscou ouest, avec une majorité de harengs juvéniles. Les géniteurs d'automne représentaient 63% de la difusion acoustique de la baie des Chaleurs, et 92% dans la région du Cap Breton. La proportion totale de géniteurs d'automne pour 4T et 4Vn combinés était de 65%; la classe d'âge dominante étant celle de 1987 à l'âge de 6 ans. La majorité (65%) des géniteurs de printemps étaient de la classe d'âge de 1991, âgés de 2 ans. La température des masses d'eau variait entre -0.5 et 13°C en 1993, avec des salinités variant de 28.0 à 34.0. Aucune difusion acoustique fut détectée à l'est du Cap Breton (4Vn) ou au sud-ouest de Terre-Neuve (3Pn) durant un relevé acoustique d'hiver en janvier, 1994.

INTRODUCTION

From 1984 to 1989, Gulf Region conducted acoustic surveys of late fall concentrations of herring in the southern Gulf using the ECOLOG system (Shotton 1986, Shotton et al. 1987 a and b, Cairns et al. 1988 and 1989, Cairns and Wright 1990). Since 1990, a Simrad EY200 echo sounder with a single-beam 120 KHz transducer has been used (LeBlanc et al. 1993).

This paper describes the October 1993 distribution and acoustic backscatter of herring in NAFO Divisions 4T and 4Vn. Survey effort was concentrated in the Chaleur Bay and Cape Breton areas, where NAFO division 4T herring congregate in the fall. Also included is a brief description of the January 1994 acoustic survey which was conducted in NAFO divisions 4Vn (eastern Cape Breton) and 3Pn (southwestern Newfoudland).

OCTOBER 1993 SURVEY

METHODS

SURVEY DESIGN, AREA AND SAMPLING

The acoustic survey was conducted according to a stratified random design, using random parallel transects within strata. Transect lines were selected from a series of points spaced 200 meters apart on the seaward boundary of a stratum. Perpendicular lines were drawn from the selected points to approximately the 10 fathom depth line inshore or to the opposite boundary line in the case of offshore strata. Strata and their boundaries were those originally used in 1989 (Cairns and Wright 1990), plus additional strata as available time and fish distribution dictated (Fig. 1).

Survey time among strata was allocated so that the density of coverage varied with the expected herring biomass. To ensure that all areas were adequately covered, we adjusted the initial time allotments so that a minimum of 4 transects were selected in each stratum. However, the East Miscou stratum, being much larger than all others, is allotted a fixed time for coverage depending on the number of sea days available. This year, the East Miscou stratum was subdivided into four substrata of equal area to permit a more intensive and thorough coverage, as well as to allow more nighttime surveying in the inshore part. These new substrata were named East Miscou northwest (EMNW), southwest (EMSW), northeast (EMNE) and southeast (EMSE) (Fig. 1, #23a, 23d, 23b and 23c).

Whenever possible, coverage of inshore strata, where most herring schools are found, was done at night when fishing for species identification and biological samples was possible. CTD (conductivity and temperature versus depth) probes were cast at preselected stations, to obtain temperature and salinity profiles of the area surveyed.

Survey itinerary

Acoustic transects were run from October 2 to 20th with the research vessel Alfred Needler. Transects were run 24 hours a day at an average speed of 8 knots. Available survey time per stratum was allocated so that the density of coverage was directly proportional to the mean backscatter density recorded for the years 1985 to 1992, plus the 1989, 1990 and 1991 proportion of seiner set sites per stratum. The coverage started with East Miscou, followed by the Gaspe area, eastern Chaleur Bay, eastern PEI (Milne), northwest and northeast Cape Breton, and Sydney Bight (Figures 2 and 3, Milne not included).

Biological Sampling

Fishing for species identification and biological samples was done at night using the IYGPT midwater trawl. However, net sounder problems on this trawl hindered the navigator's ability to catch fish, and the bottom trawl was used for some sets until the sounder was repaired. Wherever large concentrations of acoustic backscatter were detected in a particular stratum, a set was made.

The total catch of herring and other species was counted if possible or estimated, and a sample of up to 350 herring was measured. Also, a subsample of 3 herring per 0.5 cm group was frozen for subsequent detailed laboratory analysis. Catch-at-age was determined using age-length keys, and the percent numbers at age, average weight at age, and length frequency distributions were plotted.

Temperature and Salinity

CTD profiles were taken with a Seabird SBE 9 Seacat Profiler. Profiles were taken at least once per stratum, and in the majority of cases, at least once at both boundaries of the stratum. In order to summarize the data, the strata were grouped into areas: in western 4T the areas were Gaspe inshore and offshore, Chaleur northshore, southshore and offshore, and East Miscou, while in eastern 4T and 4Vn the areas were Cape Breton west inshore and offshore, Cape Breton north inshore and offshore and Cape Breton south inshore and offshore.

ACOUSTIC DATA ANALYSIS

Equipment and Calibration

The acoustic equipment consisted of a Simrad 120-25-E single beam transducer. The echo sounder used was a Simrad EY200. The signal received by the echosounder was digitized using a Femto model J9001 dual channel digitizer.

Calibrations were done with a 120 kHz calibration ball in order to confirm the receiver fixed gain and digitizer gain on our

data collection and processing system. This method is combined with TVG calibrations for the various transceiver settings used during the survey. The calibrations were performed before and after the survey.
The calibration parameters used were:
Source level and Receiver Sensitivity: 31.99 dB
TVG: 20 log R
Equivalent Ideal Beam Angle: -17.5 dB
Pulse Length: 1 m sec
Frequency: 120 kHz
Sampling Threshold: 0.25 mV

The post survey calibration indicated approximately a 2 dB increase in source level due to the replacement of a faulty power supply in the transceiver during the survey. Thus a 2 dB correction was applied to the post power supply change TVG curve calibrations to provide a new calibration file. This new file produced target strength results which were consistent with those of the calibration ball supplier.

Data Editing and Processing

All data acquisition, editing and processing were done using the Femto Model J9001 Hydroacoustic Data Processing System (HDPS). To select acoustic targets attributed to herring, verification was made by fishing whenever possible. Most of the major acoustic concentrations were identified in this manner. The visual configuration and distribution of positively identified herring acoustic targets, confirmed by many trawl sets over the years surveyed, plus acoustic logbook observations, helped in the selection process when fishing was not possible. Calculations of the mean and the variance of acoustic backscatter and biomass estimates follow procedures outlined by O'Boyle and Atkinson (1989) (Appendix 1).

The proportion of transects with recorded backscatter was determined. Also, the total mileage surveyed and the proportion thereof having herring backscatter was estimated based on the charted maps of backscatter distribution.

Target Strength

Foote's (1987) formula was used to calculate target strength based on length and weight of sampled fish (Appendix 1). Mean lengths were derived from the length frequency samples, while the weight-length regression was obtained from the detailed samples. A single target strength was calculated for the Cape Breton strata, as fish size distribution was fairly homogenous throughout the area. In Chaleur Bay, the West Miscou stratum, which had predominantly juvenile herring, was assigned a different target strength from the other strata which had adult herring (Table 1).

Foote's (1987) formula was derived from nighttime measurements of in situ herring. Experimental evidence has shown that target strength is higher during the day than at night (MacLennan and

Simmonds, 1992). Experiments with caged fish have shown that the diurnal change in target strength correlates well with the tilt angle of the fish body. This is probably caused by a change in fish behaviour associated with light level. Buerkle (1990) noted that during the day fish orient at tilt angles that are different from those at night, and suggests that applying nighttime target strengths to daytime fish orientations possibly overestimates biomass.

Since the difference between nighttime and daytime target strengths could not be quantified, the data summary tables were divided into day and night time periods (night = 1900 to 0700 HR) and an estimate of the percentage of backscatter recorded during both time periods is included.

RESULTS

Distribution of Herring and Backscatter Recorded

The distribution of herring encountered during the October 1993 survey in Chaleur Bay and Cape Breton is mapped in Figures 2 and 3. The total acoustic scattering intensity of herring detected in each stratum is indicated by relative magnitudes in Figures 4 and 5. The western and central parts of Chaleur Bay, as well as the North Miscou stratum could not be surveyed due to a malfunction in the acoustic transceiver and subsequent time lost for repairs.

The acoustic backscatter recorded per transect within a stratum is summarized in Tables 2a) Chaleur nighttime, 2b) Chaleur daytime, 2c) Cape Breton nighttime and 2d) Cape Breton daytime. The total per stratum values (nighttime plus daytime) are summarized in Table 3.

The Riviere-au-Renard and Pointe Seche strata of the north Gaspe coast were added in 1993 after reports of seiner activity in the area. They are included with the Chaleur backscatter data in Tables 2a and 2b, as well as the per stratum results in Table 3. Also in 1993, the Laurentian-1 and Laurentian-2 strata were added to explore the northern tip of Cape Breton to St. Paul's Island, while the Milne strata of eastern PEI were added in 1992. These strata are included with the Cape Breton backscatter data in Tables 2c and 2d, as well as in Table 3.

In 1993, 75% of the total backscatter was recorded in the East Miscou strata, of which 72% came from the inshore strata EMNW and EMSW (Table 3 and 4b). The highest concentrations found in the eastern portion of Chaleur Bay were in the West Miscou stratum, which accounted for 12% of the total backscatter. The Cape Breton area accounted for 9% of the 1993 backscatter, which was found mostly inshore in the Aspy Bay and Neil Harbour strata.

Total Backscatter and Biomass Estimates

Total acoustic backscattering and biomass estimates, using

Foote's (1987) formula for target strength, in the Southern Gulf in October 1991 to 1993, by area, are presented in Table 4a and Fig. 6. Included in Table 4a are the proportions of transects surveyed during nighttime (1900 - 0700 HR) and the proportion of backscatter and biomass which was recorded at night.

The 1993 estimate is lower than 1992. Most of the 1993 backscatter and biomass were located in the Chaleur inshore area due to the separation of the whole East Miscou strata into inshore and offshore, and the inclusion of the East Miscou substrata EMNW and EMSW in the Chaleur inshore area. In 1991 and 1992, the Chaleur offshore area had the highest proportion of total backscatter and biomass, because the entire East Miscou stratum backscatter was included with the offshore.

Table 4b summarizes the East Miscou strata October total acoustic backscatter and biomass estimates for 1991 to 1993. It includes the percentage of total Gulf biomass detected in this area. In 1993, 76% of the total came from this area, with 47% in 1992 and 52% in 1991.

The proportion of total survey backscatter and biomass detected at night was 85% in 1993, and 75% in 1992 and 1991. In the East Miscou strata, 91% of the backscatter was detected at night in 1993, 80% in 1992 and 68% in 1991. Any daytime overestimate of biomass derived by applying nighttime target strengths to daytime backscatter would be relatively lower in 1993 than in previous years.

The largest number of transects surveyed was in 1992. This reduced considerably the coefficient of variation values for the Chaleur Bay inshore strata. In 1993, transceiver malfunction resulted in the loss of 30% coverage in this area.

Figure 6 shows the biomass estimates for October from 1991 to 1993. It gives the relative importance by area contributing to the total biomass estimate. The 1993 total value is lower than 1992, but the relative contribution of the East Miscou strata is higher. In 1993, both Chaleur Bay as a whole and Cape Breton have lower biomass than 1992.

Table 4c summarizes the total biomass estimates from November acoustic surveys held in the southern Gulf from 1984 to 1990. A stratified random survey design with parallel transects within strata was implemented in 1988, prior to which a random zig-zag transect survey design was used. The highest estimates in this time series were in 1987 and 1990, followed by intermediary values in 1986 and 1988, and lower values in 1984 and 1985.

Proportion of Transects with Backscatter

The total number of transects per stratum and the proportion of transects with backscatter recorded from the 1990 to 1993 herring acoustic surveys are recorded in Table 5.

The 1993 results include the subdivided East Miscou stratum in the Chaleur offshore area. Compared to other years, this area had the highest proportion of transects with backscatter, with a value of 0.53.

The 1992 survey had the highest overall proportion of transects with backscatter recorded (0.67) as well as for each of the areas: Chaleur total (0.64), and Cape Breton (0.79). 1991 shows the second highest proportions with an overall value of 0.46, followed closely by 1993 with 0.42. In contrast, 1990 showed the lowest values, with an overall proportion of 0.22.

Percentage of Transect Length with Backscatter

Table 6 is a resume of total transect length in nautical miles covered per stratum, together with the total transect length showing herring backscatter signals, and the percentage of transect length covered with backscatter, for the years 1990 to 1993.

The 1993 survey had the lowest overall percentage length of transect with backscatter recorded (7.5%). This is mainly due to the high concentrations encountered in the East Miscou strata, which accounted for 75% of the overall backscatter recorded, while other areas had scarce backscatter signals.

The 1991 and 1992 surveys have the highest overall percentage length of transect with backscatter. The 1991 survey had 16.7%, with the Chaleur area at 17.1% and the Cape Breton area at 15.2%. However, 1991 had very few offshore transects, which usually have less backscatter; this accounts for the high percentage. In 1992, the total transect length covered was almost double than 1991. The overall percentage was 14%, with Chaleur having 13.1% and Cape Breton 17%.

Trawl sets and sample composition

Herring lengths, weights and spawning affinities from the 1990 to 1993 acoustic survey samples are summarized in Table 1.

The 1993 survey set locations can be found in Figures 2 and 3, and are listed in Table 3. Length frequency distributions of herring samples are shown in Figure 7.

Mostly adult herring were found in sets both in Chaleur Bay and the Cape Breton area. Juvenile herring were found predominantly in the West Miscou stratum set. The northern Cape Breton area samples in Pleasant Bay and Aspy Bay had larger herring. The Chaleur Bay samples were composed of 63% fall spawners while the Cape Breton area's were 92% fall spawners.

Catch-at-age

Catch-at-age matrices for 4T and 4Vn herring, as well as 4TVn combined, weighted by the total backscatter proportions for each area (Chaleur and Cape Breton), are presented in Table 7a for fall spawners and Table 7b for spring spawners.

The fall spawners (Table 7a) represented 65% of the 1993 total backscatter detected, 76% of the 1992 total, and 70% of the 1991 total. In 1990, this percentage was down to 38%, mainly because of the large proportion of juveniles, which were mostly spring spawners. In 1993, the dominant year-class was 1987, as 6 year-

olds. As seen in Figure 8a, the percent number at age of the 1987 year-class has been around 40% since 1991 in 4T, and is still dominant in 4T-4Vn numbers combined (Fig. 8c). In general, there is a noticeable decrease in average weight at age for fall spawners in 4T and 4Vn from 1988 to 1993 (Table 8).

For the spring spawners, the strongest year-class was 1991 which accounted for 65% of the 1993 spring spawners (Table 7b). The strong 1988 year-class present in 1992 was not as strong in 1993 (Fig. 8b and 8c). The average weight at age for spring spawners in 4T-4Vn also shows some decreasing values from 1988 to 1993 (Table 8).

Temperature and Salinity

A total of 73 CTD profiles were taken during the 1993 survey. Figure 9a indicates the CTD locations for Chaleur, East Miscou and Gaspe areas, while Figure 9b locates the Milne and Cape Breton casts. The temperature by area versus depth (TD) and salinity (TS) plots are derived from all the CTD profiles obtained within that area. Figure 10a summarizes the 1993 TD and TS plots for Chaleur northshore, offshore, southshore and East Miscou. Figure 10b shows the Gaspe and Cape Breton west inshore and offshore TD and TS plots, while Figure 10c plots the Cape Breton north and south inshore and offshore areas.

Temperatures in all areas and at all depth ranges varied between -0.5 and 13 °C. In 1993, the East Miscou area had the widest temperature range (from 13 to -0.5 °C) with a well defined thermocline between the 25 and 50 meters. Salinities on the practical salinity scale ranged from 28.0 in surface waters to 32.5 in the deeper cold water layer. The Chaleur offshore and Gaspe areas have similar patterns of temperature and salinity gradients, with a narrower range. The Cape Breton west, north and south areas have higher surface temperatures than Chaleur and Gaspe. The offshore areas of Cape Breton west and south show three distinct water masses; a warm-low salinity surface layer, an intermediate very cold and higher salinity mass, and a deeper warmer-high salinity layer.

DISCUSSION

In the 1993 acoustic survey (Oct. 1 to Oct. 22) the main herring concentrations, representing 75% of the total survey backscatter recorded, were detected in the East Miscou area, a traditional herring location in October. However, very few herring signals were recorded in the northeastern Chaleur Bay area of Shigawake, Newport and Grande-Riviere, which have also been traditional areas of herring concentrations in past years. The presence of herring schools in the western part of the bay was noticed on the ship's sounder, but could not be recorded due to

echosounder malfunction. The latter part of the survey covered northwest and northeast Cape Breton, as well as Sydney Bight, but herring was detected in small dispersed patches only. The 1992 and 1991 surveys had a more widespread distribution of herring in both the Chaleur Bay area and northern Cape Breton.

The biomass estimate for October 1993 was 130848 tons. As a relative index, it is lower than the 1992 value. The absolute value is lower than the 1993 VPA model estimate using the ADAPT framework in the assessment for 4T fall spawners (Claytor et al., 1994). However, parts of the Chaleur Bay area could not be surveyed during the 1993 acoustic survey.

JANUARY 1994 SURVEY

Methods

A winter herring acoustic survey was conducted from January 5 to 13 in the NAFO areas 4Vn and 3Pn aboard the Alfred Needler, as part of a joint pelagic-groundfish survey. The same protocol that was used in October 1993 was followed for selecting transects and for equipment calibration. Mechanical problems with the Alfred Needler, the loss of an anchor and bad weather resulted in 4 days of lost survey time. Of the time remaining, only inshore areas could be surveyed due to weather conditions.

Results

The ship's sounder was monitored while steaming from Halifax to eastern Cape Breton, but no signs of fish schools were detected. Approximately 100 transect lines were covered with the hydroacoustic gear in the areas surveyed, and a total of 16 hydrographic profiles were taken at predetermined stations with a CTD probe (Figures 11a and 11b).

All the 4Vn inshore strata off eastern Cape Breton were covered; that is, the area from the coast to a distance within 5 to 10 nautical miles offshore. Weather conditions did not permit the ship to approach the coastline any closer than 0.3 to 0.5 nautical miles. No acoustic backscatter was detected in this area (Fig. 11a).

The crossing of the Laurentian Channel to southern Newfoundland's 3Pn area was monitored on the ship's sounder in both directions, with no signs of fish present. The 3Pn area was covered by hydroacoustic gear for 20 hours; lines were run perpendicular to the coast up to a distance of 5 nautical miles offshore. Coverage started in the Connoire Bay area to the east and stopped in the Rose Blanche area westward, with an incursion into La Folie Bay (Fig. 11b). Again no acoustic signals were detected, and extending the coverage was not possible due to a lack of time.

The temperature versus depth (TD) and temperature versus salinity (TS) plots combined by bottom depth range (Fig. 12a and

12b, Appendix 2) are derived from all the CTD profiles obtained within a bottom depth range for the area. Figure 12a summarizes the January 1994 TD and TS plots for Cape Breton bottom depth ranges 0-25 meters, 25-50 m, 50-100 m and 100-150 meters. Surface temperatures in Cape Breton varied between -0.5 and 0.5 °C. A deep, more saline and warmer water layer is detected below the 75 meter depth, and is more apparent below the 125 meter depth line. In the southwest Newfoundland area (Fig. 12b), surface waters were a bit warmer (from 0.5 to 1 °C) with a well defined thermocline and halocline offshore between the 100 and 150 meter depth range.

Discussion

These results show that no herring were located in inshore areas of 4Vn and 3Pn from January 5 to January 13, 1994. However, bad weather prevented us from surveying further offshore in areas more than 5 to 10 nautical miles from the coast. The groundfish second leg of the survey did locate herring concentrations in areas further offshore in depths of over 100 meters. This would coincide with the deeper, warmer water layer which is below the 100 meter depth line.

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Table 1. Lengths, weights, spawning affinities and calculated target strengths for 1990-93 herring acoustic surveys.

Area and Year	Samples	Mean Length (cm)	Number	Weight at Mean Length (g)	Weight Formula	Percent Fall Spawners by Weight	Target@@ Strength (dB/kg)
CHALEUR							
1993	Chaleur	28.0	598	166.9	$0.00328*len^{3.252}$	63**	-35.2
	W.Miscou@	24.8	271	111.4	$0.01760*len^{2.726}$	63**	-34.6
1992	Adult	27.7	3454	159.0	$0.00467*len^{3.146}$	71**	-35.10
	Juvenile*	21.3	619	71.0	$0.00552*len^{3.091}$	71**	-33.82
1991	all	27.6	2581	160.5	$0.00588*len^{3.079}$	68	-35.14
1990	East	27.0	272	155.1	$0.00211*len^{3.40}$	32**	-35.18
1990	West***	23.2	1709	89.8	$0.00393*len^{3.192}$	32**	-34.13
CAPE BRETON							
1993	all	30.2	960	199.5	$0.00700*len^{3.01}$	92	-35.30
1992	all	32.6	796	254.5	$0.00685*len^{3.02}$	96	-35.69
1991	all	33.5	631	275.3	$0.01053*len^{2.897}$	99	-35.80
1990	all	32.9	833	263.2	$0.00843*len^{2.963}$	92	-35.76

* Juvenile herring samples, New Carlilse & Anse a Beaufils strata

** Percentage represents all Chaleur samples combined

*** Mostly juvenile herring

@ Juvenile and young adults combined

@@ Foote's target strength formula (1987)

TABLE 2a. Nighttime backscatter and biomass for Chaleur transects (1900-0700hr).

Stratum	Transect Number	Transect Length (m)	Transect Area (km²)	Target* Strength (dB/kg)	Sa - Area Scattering (/sr)	Total Scattering (m²/sr)	Biomass Density (Kg/m²)	Total Biomass (t/trans)	Set Number
EAST_MISCOU_SW	11	12919	68.83	-35.2	0.000012	839	0.0404	2778.193	
	12	12919	68.83	-35.2	0.000012	839	0.0404	2778.193	
	13	12903	68.74	-35.2	0.000013	897	0.0432	2969.267	1
	14	12506	66.63	-35.2	0.000013	846	0.0420	2801.432	
	15	12273	65.38	-35.2	0.000022	1424	0.0721	4714.104	
	16	12687	67.59	-35.2	0.000009	601	0.0294	1988.482	2
EAST_MISCOU_NW	28	13048	69.51	-35.2	0.000070	4841	0.2306	16028.414	3
	30	12423	66.18	-35.2	0.000098	6505	0.3255	21541.577	
	31	12336	65.72	-35.2	0.000174	11410	0.5749	37780.611	4
	32	12132	64.63	-35.2	0.000000	1	0.0000	1.747	
	33	12374	65.92	-35.2	0.000000	6	0.0003	19.346	
	34	12663	67.46	-35.2	0.000001	38	0.0019	127.094	
	35	13142	70.01	-35.2	0.000000	0	0.0000	0.899	
GASPE_BAY	46	6491	10.58	-35.2	0.000000	0	0.0000	0.000	
	47	6465	10.54	-35.2	0.000000	0	0.0000	0.000	
	48	6215	10.14	-35.2	0.000000	0	0.0000	0.000	
	49	5131	8.37	-35.2	0.000000	0	0.0000	0.000	
	51	4977	8.12	-35.2	0.000000	0	0.0000	0.000	
	53	2539	4.14	-35.2	0.000000	0	0.0000	0.000	
	54	2366	3.86	-35.2	0.000000	0	0.0000	0.000	
CAP_BON-AMI	55	9182	8.51	-35.2	0.000000	0	0.0000	0.000	
	56	9874	9.15	-35.2	0.000000	0	0.0000	0.000	
	57	9268	8.59	-35.2	0.000000	0	0.0000	0.000	
	58	9999	9.26	-35.2	0.000000	0	0.0000	0.000	
	59	10002	9.27	-35.2	0.000000	0	0.0000	0.000	
	60	8076	7.48	-35.2	0.000000	0	0.0000	0.000	
	61	7817	7.24	-35.2	0.000000	0	0.0000	0.000	
	62	7808	7.23	-35.2	0.000000	0	0.0000	0.000	
	63	7878	7.30	-35.2	0.000000	0	0.0000	0.000	
	64	7209	6.68	-35.2	0.000000	0	0.0000	0.000	
LA_MALBAIE	85	14016	16.46	-35.2	0.000000	0	0.0000	0.000	5
	86	14854	17.44	-35.2	0.000000	0	0.0000	0.000	6
	88	15386	18.06	-35.2	0.000000	3	0.0006	11.155	
	89	15025	17.64	-35.2	0.000000	2	0.0003	6.023	
	90	14966	17.57	-35.2	0.000000	0	0.0000	0.000	
	91	15298	17.96	-35.2	0.000003	58	0.0106	191.225	
	92	14386	16.89	-35.2	0.000000	2	0.0003	5.848	
	93	13498	15.85	-35.2	0.000000	0	0.0000	0.000	
	94	12124	14.23	-35.2	0.000000	0	0.0000	0.000	
	95	10183	11.96	-35.2	0.000000	0	0.0000	0.000	
	96	6905	8.11	-35.2	0.000000	0	0.0000	0.000	
BEAUFILS	113	9691	17.06	-35.2	0.000000	0	0.0000	0.000	
	114	8114	14.28	-35.2	0.000000	0	0.0000	0.000	
	115	7886	13.88	-35.2	0.000000	0	0.0000	0.000	
	116	3895	6.86	-35.2	0.000000	0	0.0000	0.000	
GRAND_RIVIERE	117	3810	3.79	-35.2	0.000000	0	0.0000	0.000	
	118	5733	5.70	-35.2	0.000000	0	0.0000	0.000	
	119	6888	6.85	-35.2	0.000001	6	0.0028	18.885	
	120	6733	6.70	-35.2	0.000000	0	0.0000	0.000	
	122	6351	6.32	-35.2	0.000001	4	0.0022	13.740	
	123	7123	7.09	-35.2	0.000003	24	0.0113	79.943	
	124	7338	7.30	-35.2	0.000001	4	0.0020	14.756	
	125	7750	7.71	-35.2	0.000001	8	0.0036	27.885	
	126	7990	7.95	-35.2	0.000000	1	0.0004	2.934	
	127	7488	7.45	-35.2	0.000000	0	0.0000	0.000	
	128	6631	6.60	-35.2	0.000000	0	0.0000	0.000	
	129	6499	6.47	-35.2	0.000000	0	0.0000	0.000	
	130	6721	6.69	-35.2	0.000000	0	0.0000	0.000	
	131	6794	6.76	-35.2	0.000000	0	0.0000	0.000	
	132	6991	6.95	-35.2	0.000000	0	0.0002	1.510	
	133	5537	5.51	-35.2	0.000000	0	0.0000	0.000	
	134	6510	6.48	-35.2	0.000002	15	0.0075	48.743	
	135	5984	5.95	-35.2	0.000000	0	0.0000	0.000	
	136	6131	6.10	-35.2	0.000000	0	0.0000	0.000	

TABLE 2a. Nighttime backscatter and biomass for Chaleur transects (1900-0700hr).

Stratum	Transect Number	Transect Length (m)	Transect Area (km²)	Target* Strength (dB/kg)	Sa - Area Scattering (/sr)	Total Scattering (m²/sr)	Biomass Density (Kg/m²)	Total Biomass (t/trans)	Set Number
NEWPORT	138	5316	8.09	-35.2	0.000000	0	0.0000	0.000	
	139	5868	8.93	-35.2	0.000000	0	0.0000	0.000	
	140	5506	8.38	-35.2	0.000000	0	0.0000	0.000	
	141	7855	11.96	-35.2	0.000000	0	0.0000	0.000	
	142	7429	11.31	-35.2	0.000000	0	0.0000	0.000	
	143	5970	9.09	-35.2	0.000000	0	0.0000	0.000	
	144	8097	12.33	-35.2	0.000000	0	0.0000	0.000	
	145	8394	12.78	-35.2	0.000000	0	0.0000	0.000	
	146	8755	13.33	-35.2	0.000000	0	0.0000	0.000	
PTE_SECHE	157	3723	5.31	-35.2	0.000000	0	0.0000	0.000	
	158	4336	6.18	-35.2	0.000000	0	0.0000	0.000	
	159	4659	6.64	-35.2	0.000000	0	0.0000	0.000	10
	160	4575	6.52	-35.2	0.000036	237	0.1204	784.899	
	161	3846	5.48	-35.2	0.000000	0	0.0000	0.000	
	162	5544	7.90	-35.2	0.000002	13	0.0055	43.087	8
	163	4667	6.65	-35.2	0.000000	0	0.0000	0.000	9
	164	4895	6.98	-35.2	0.000000	0	0.0000	0.000	
	165	4788	6.83	-35.2	0.000000	0	0.0000	0.000	
	166	4570	6.51	-35.2	0.000000	0	0.0000	0.000	
	167	4600	6.56	-35.2	0.000000	0	0.0000	0.000	
	168	4165	5.94	-35.2	0.000000	0	0.0000	0.000	
	169	4111	5.86	-35.2	0.000000	0	0.0000	0.000	
WEST_MISCOU	185	8200	20.19	-34.6	0.000013	268	0.0383	772.992	
	186	9273	22.83	-34.6	0.000010	217	0.0274	625.814	11
	187	9209	22.67	-34.6	0.000011	239	0.0304	689.838	
	188	9472	23.32	-34.6	0.000014	330	0.0408	952.436	
	189	9719	23.93	-34.6	0.000026	612	0.0738	1764.713	
	190	9463	23.30	-34.6	0.000015	353	0.0437	1019.015	
	191	10021	24.67	-34.6	0.000014	337	0.0394	970.820	
	192	11909	29.32	-34.6	0.000021	628	0.0618	1811.591	
	193	8114	19.98	-34.6	0.000019	377	0.0544	1087.460	
	194	7841	19.30	-34.6	0.000031	606	0.0906	1748.097	
	196	7210	17.75	-34.6	0.000007	119	0.0193	343.431	
EST_CENT_CHALEU	205	10291	47.29	-35.2	0.000000	0	0.0000	0.000	
SHIGAWAKE	206	5690	12.76	-35.2	0.000000	0	0.0000	0.000	
	207	6081	13.64	-35.2	0.000000	0	0.0000	0.000	
	208	7896	17.71	-35.2	0.000000	0	0.0000	0.000	
	209	8316	18.65	-35.2	0.000000	0	0.0000	0.000	
	210	6920	15.52	-35.2	0.000000	0	0.0000	0.000	
	211	6346	14.24	-35.2	0.000000	0	0.0000	0.000	
	212	6150	13.79	-35.2	0.000000	0	0.0000	0.000	
	213	5667	12.71	-35.2	0.000000	0	0.0000	0.000	
	214	5564	12.48	-35.2	0.000000	0	0.0000	0.000	
	215	5129	11.50	-35.2	0.000000	0	0.0000	0.000	
	216	5025	11.27	-35.2	0.000000	0	0.0000	0.000	
	217	4898	10.99	-35.2	0.000000	0	0.0000	0.000	
	218	5107	11.46	-35.2	0.000000	0	0.0000	0.000	
	219	4446	9.97	-35.2	0.000000	0	0.0000	0.000	
	220	5313	11.92	-35.2	0.000000	0	0.0000	0.000	
	221	4891	10.97	-35.2	0.000000	0	0.0000	0.000	
	222	3162	7.09	-35.2	0.000000	0	0.0000	0.000	
	223	5098	11.43	-35.2	0.000000	0	0.0000	0.000	

* Foote's target strength (1987)

TABLE 2b. Daytime backscatter and biomass for Chaleur transects (0700-1900hr).

Stratum	Transect Number	Transect Length (m)	Transect Area (km²)	Target* Strength (dB/kg)	Sa - Area Scattering (/sr)	Total Scattering (m²/sr)	Biomass Density (Kg/m²)	Total Biomass (t/trans)	Set Number
EAST_MISCOU_SE	3	12591	67.08	-35.2	0.000002	102	0.0050	338.008	
	4	12764	68.00	-35.2	0.000002	126	0.0061	415.595	
	5	12207	65.03	-35.2	0.000003	184	0.0094	610.840	
	6	12712	67.72	-35.2	0.000001	44	0.0022	146.554	
	7	12585	67.04	-35.2	0.000001	82	0.0040	271.316	
	8	12683	67.57	-35.2	0.000001	80	0.0039	266.237	
	9	12426	66.20	-35.2	0.000001	50	0.0025	166.916	
	10	13148	70.04	-35.2	0.000000	6	0.0003	20.005	
EAST_MISCOU_SW	17	12924	68.85	-35.2	0.000012	818	0.0394	2709.417	
	18	13139	70.00	-35.2	0.000010	726	0.0343	2402.520	
EAST_MISCOU_NE	19	12738	67.86	-35.2	0.000008	514	0.0251	1701.148	
	20	13037	69.45	-35.2	0.000000	24	0.0011	79.605	
	21	12404	66.08	-35.2	0.000001	68	0.0034	225.081	
	22	12699	67.65	-35.2	0.000000	0	0.0000	0.000	
	24	12445	66.30	-35.2	0.000000	0	0.0000	0.000	
	25	12902	68.73	-35.2	0.000000	0	0.0000	0.000	
	26	12816	68.28	-35.2	0.000000	0	0.0000	0.000	
	27	12842	68.41	-35.2	0.000000	0	0.0000	0.000	
EAST_MISCOU_NW	36	12724	67.78	-35.2	0.000000	0	0.0000	0.000	
AMERICAN_BANK	37	9086	124.59	-35.2	0.000000	0	0.0000	0.000	
	38	9384	128.68	-35.2	0.000000	0	0.0000	0.000	
GASPE_BAY	42	6064	9.89	-35.2	0.000000	0	0.0000	0.000	
	43	6473	10.55	-35.2	0.000000	0	0.0000	0.000	
	44	6457	10.53	-35.2	0.000000	3	0.0008	8.292	
CAP_BON-AMI	65	7060	6.54	-35.2	0.000000	0	0.0000	0.000	
	66	6760	6.26	-35.2	0.000000	0	0.0000	0.000	
	67	6513	6.03	-35.2	0.000000	0	0.0000	0.000	
	68	5259	4.87	-35.2	0.000000	0	0.0000	0.000	
GASPE_OFF	69	8805	10.06	-35.2	0.000000	0	0.0000	0.000	
	70	8808	10.06	-35.2	0.000000	0	0.0000	0.000	
	72	9162	10.47	-35.2	0.000000	0	0.0000	0.000	
	73	9532	10.89	-35.2	0.000000	0	0.0000	0.000	
	74	9865	11.27	-35.2	0.000000	0	0.0000	0.000	
	75	10587	12.10	-35.2	0.000000	0	0.0000	0.000	
	76	11297	12.91	-35.2	0.000000	0	0.0000	0.000	
	78	12781	14.60	-35.2	0.000000	0	0.0000	0.000	
	79	12619	14.42	-35.2	0.000000	0	0.0000	0.000	
	80	10825	12.37	-35.2	0.000000	0	0.0000	0.000	
	81	9594	10.96	-35.2	0.000000	0	0.0000	0.000	
	82	8970	10.25	-35.2	0.000000	0	0.0000	0.000	
LA_MALBAIE	83	6833	8.01	-35.2	0.000000	0	0.0000	0.000	
BONAVENTURE_OFF	97	11509	50.12	-35.2	0.000000	0	0.0000	0.000	
	98	8050	35.06	-35.2	0.000000	11	0.0011	37.381	
	99	7131	31.05	-35.2	0.000000	4	0.0004	11.825	
	100	4712	20.52	-35.2	0.000000	1	0.0001	2.648	
BEAUFILS_OFF	101	7244	33.56	-35.2	0.000000	2	0.0002	7.922	
	102	7162	33.18	-35.2	0.000000	0	0.0000	0.000	
	103	6533	30.26	-35.2	0.000000	0	0.0000	0.000	
	104	7359	34.09	-35.2	0.000000	0	0.0000	0.000	
BEAUFILS	105	6375	11.22	-35.2	0.000000	0	0.0000	0.000	
	106	7051	12.41	-35.2	0.000000	0	0.0000	0.000	
	107	6012	10.58	-35.2	0.000000	0	0.0000	0.000	
	108	5918	10.42	-35.2	0.000000	0	0.0000	0.000	
	109	5873	10.34	-35.2	0.000000	0	0.0000	0.000	
	110	9988	17.58	-35.2	0.000000	0	0.0000	0.000	
	111	9978	17.56	-35.2	0.000000	0	0.0000	0.000	
	112	9856	17.35	-35.2	0.000000	0	0.0000	0.000	
NEWPORT	147	9386	14.29	-35.2	0.000000	0	0.0000	0.000	
	148	8856	13.48	-35.2	0.000001	16	0.0040	53.582	
	149	8392	12.77	-35.2	0.000000	4	0.0009	12.118	
	150	8438	12.84	-35.2	0.000000	2	0.0006	7.906	
	151	7378	11.23	-35.2	0.000001	7	0.0021	23.989	
GR_RIVIERE_OFF	152	12121	64.01	-35.2	0.000000	29	0.0015	96.197	
	153	8833	46.65	-35.2	0.000000	0	0.0000	1.572	
	154	8392	44.32	-35.2	0.000000	0	0.0000	0.000	
	155	7216	38.11	-35.2	0.000000	0	0.0000	0.000	

TABLE 2b. Daytime backscatter and biomass for Chaleur transects (0700-1900hr).

Stratum	Transect Number	Transect Length (m)	Transect Area (km^2)	Target* Strength (dB/kg)	Sa - Area Scattering (/sr)	Total Scattering (m^2/sr)	Biomass Density (Kg/m^2)	Total Biomass (t/trans)	Set Number
RIVIERE_RENARD	156	5949	13.78	-35.2	0.000000	0	0.0000	0.000	
	174	1653	3.83	-35.2	0.000000	0	0.0000	0.000	
	175	2392	5.54	-35.2	0.000000	0	0.0000	0.000	
	176	2024	4.69	-35.2	0.000004	20	0.0141	65.934	
	178	3170	7.34	-35.2	0.000007	51	0.0228	167.475	
	179	3252	7.53	-35.2	0.000028	208	0.0914	688.705	
	180	3809	8.82	-35.2	0.000007	64	0.0241	213.051	
	181	3535	8.19	-35.2	0.000018	149	0.0602	493.079	
WEST_MISCOU	182	10667	26.26	-34.6	0.000002	53	0.0058	151.821	
	183	10896	26.83	-34.6	0.000001	19	0.0020	54.948	
	184	10622	26.15	-34.6	0.000011	299	0.0329	861.571	
NEWPORT_OFF	197	12397	62.79	-35.2	0.000000	0	0.0000	0.000	
	198	12451	63.06	-35.2	0.000000	0	0.0000	0.000	
	199	11809	59.81	-35.2	0.000000	0	0.0000	0.000	
	200	9647	48.86	-35.2	0.000000	0	0.0000	0.000	
	201	8834	44.74	-35.2	0.000000	0	0.0000	0.000	
	202	8669	43.90	-35.2	0.000000	0	0.0000	0.000	
EST_CENT_CHALEU	203	9840	45.22	-35.2	0.000000	0	0.0000	0.000	
	204	9664	44.41	-35.2	0.000000	0	0.0000	0.000	
	226	10741	49.36	-35.2	0.000000	0	0.0000	0.000	
	227	11276	51.82	-35.2	0.000000	0	0.0000	0.000	
SHIGAWAKE	224	5256	11.79	-35.2	0.000000	0	0.0000	0.000	
CENTRAL_CHALEUR	228	10689	55.46	-35.2	0.000000	0	0.0000	0.000	
	229	9260	48.05	-35.2	0.000000	0	0.0000	0.000	
	230	8930	46.33	-35.2	0.000000	0	0.0000	0.000	
	231	9843	51.07	-35.2	0.000000	0	0.0000	0.000	

* Foote's target strength (1987)

TABLE 2c. Nighttime backscatter and biomass for Cape Breton transects (1900-0700hr).

Stratum	Transect Number	Transect Length (m)	Transect Area (km²)	Target* Strength (dB/kg)	Sa - Area Scattering (/sr)	Total Scattering (m²/sr)	Biomass Density (Kg/m²)	Total Biomass (t/trans)	Set Number
MILNE	245	7617	28.23	-35.3	0.000000	0	0.0000	0.000	
	246	6899	25.57	-35.3	0.000000	0	0.0000	0.000	
	247	6708	24.86	-35.3	0.000000	0	0.0000	0.000	
	248	5547	20.56	-35.3	0.000000	0	0.0000	0.000	
WHITE_CAPE_OFF	258	8417	50.30	-35.3	0.000000	0	0.0000	0.000	
WHITE_CAPE	259	9058	27.28	-35.3	0.000000	0	0.0000	0.000	
	260	9368	28.21	-35.3	0.000000	0	0.0000	0.000	
	261	7907	23.81	-35.3	0.000000	0	0.0000	0.000	
	262	6855	20.64	-35.3	0.000000	0	0.0000	0.000	
	263	7040	21.20	-35.3	0.000000	0	0.0000	0.000	
	264	6511	19.61	-35.3	0.000000	0	0.0000	0.000	
	265	6746	20.31	-35.3	0.000000	0	0.0000	0.000	
	266	6452	19.43	-35.3	0.000000	0	0.0000	0.000	
PLEASANT_BAY	267	8751	36.69	-35.3	0.000003	111	0.0102	375.535	12
	271	8840	37.06	-35.3	0.000004	148	0.0135	501.724	13
	272	9125	38.26	-35.3	0.000000	0	0.0000	0.000	
	273	6401	26.84	-35.3	0.000000	0	0.0000	0.000	
	274	6331	26.54	-35.3	0.000000	0	0.0000	0.000	
	275	6461	27.09	-35.3	0.000000	0	0.0000	0.000	
LAURENTIAN-1	285	10697	49.56	-35.3	0.000000	0	0.0000	0.000	
LAURENTIAN-2	286	11213	51.94	-35.3	0.000000	0	0.0000	0.000	
	287	15209	70.46	-35.3	0.000000	0	0.0000	0.000	
	288	18164	84.15	-35.3	0.000000	0	0.0000	0.000	
	289	15903	73.67	-35.3	0.000000	0	0.0000	0.000	
BAY_ST_LAWRENCE	290	5393	13.49	-35.3	0.000000	0	0.0000	0.000	
	291	5703	14.27	-35.3	0.000000	0	0.0000	0.000	
	292	6992	17.49	-35.3	0.000000	1	0.0001	2.165	
	293	6426	16.08	-35.3	0.000000	0	0.0000	0.000	
	294	8857	22.16	-35.3	0.000001	12	0.0018	38.993	
	295	9528	23.84	-35.3	0.000000	0	0.0000	0.000	
	296	9334	23.35	-35.3	0.000004	83	0.0121	281.534	
ASPY_BAY	313	10083	22.61	-35.3	0.000005	121	0.0182	411.022	
	314	10248	22.98	-35.3	0.000003	66	0.0097	222.071	
	315	9516	21.34	-35.3	0.000000	6	0.0009	19.488	
	316	8706	19.52	-35.3	0.000000	10	0.0017	32.882	
	318	4068	9.12	-35.3	0.000000	0	0.0000	0.000	
	319	3281	7.36	-35.3	0.000000	0	0.0000	0.000	
NEIL_HARBOUR	320	4877	13.76	-35.3	0.000004	58	0.0143	196.844	
	321	5227	14.75	-35.3	0.000001	16	0.0036	52.753	
	323	5107	14.41	-35.3	0.000002	28	0.0065	93.331	
	324	9712	27.39	-35.3	0.000001	36	0.0045	122.181	
	325	9514	26.84	-35.3	0.000002	66	0.0083	222.491	
	326	10859	30.63	-35.3	0.000001	37	0.0041	125.205	
	327	10904	30.76	-35.3	0.000007	217	0.0240	736.753	
	328	10657	30.06	-35.3	0.000001	30	0.0034	101.664	
NEW_WATRFRD_OFF	395	10315	40.14	-35.3	0.000003	137	0.0116	464.534	
NEW_WATERFORD	340	8809	13.87	-35.3	0.000002	27	0.0066	90.967	
	341	8547	13.46	-35.3	0.000000	6	0.0014	19.277	
	342	9505	14.97	-35.3	0.000001	18	0.0040	59.730	
	343	9169	14.44	-35.3	0.000000	0	0.0000	0.000	
	344	7592	11.96	-35.3	0.000000	1	0.0004	4.990	
	345	7501	11.81	-35.3	0.000000	4	0.0010	12.022	
	346	8078	12.72	-35.3	0.000000	0	0.0000	0.000	
	347	8000	12.60	-35.3	0.000000	0	0.0000	0.000	
SYDNEY	348	11559	21.69	-35.3	0.000001	16	0.0026	55.480	
	349	12497	23.45	-35.3	0.000001	30	0.0043	100.887	
	350	11710	21.97	-35.3	0.000001	16	0.0024	52.852	
	351	11303	21.21	-35.3	0.000000	8	0.0013	27.414	
	352	10990	20.62	-35.3	0.000000	0	0.0000	0.000	
	353	9431	17.69	-35.3	0.000001	9	0.0018	32.091	
	354	7045	13.22	-35.3	0.000003	37	0.0095	125.302	
	355	6701	12.57	-35.3	0.000003	37	0.0098	123.683	
HADDOCK BANK	356	7181	15.02	-35.3	0.000000	4	0.0010	14.300	
	357	8495	17.76	-35.3	0.000000	6	0.0012	21.786	

TABLE 2c. Nighttime backscatter and biomass for Cape Breton transects (1900-0700hr).

Stratum	Transect Number	Transect Length (m)	Transect Area (km^2)	Target* Strength (dB/kg)	Sa - Area Scattering (/sr)	Total Scattering (m^2/sr)	Biomass Density (Kg/m^2)	Total Biomass (t/trans)	Set Number
WRECK_COVE	368	7438	13.61	-35.3	0.000001	15	0.0038	51.827	
	369	7567	13.85	-35.3	0.000000	6	0.0014	19.975	
	370	7445	13.62	-35.3	0.000001	8	0.0019	26.181	
	371	7549	13.81	-35.3	0.000000	3	0.0008	11.023	
	372	7949	14.55	-35.3	0.000001	12	0.0027	39.482	17
	374	7731	14.15	-35.3	0.000000	5	0.0012	17.361	
	375	7779	14.23	-35.3	0.000001	21	0.0049	69.577	
	376	7387	13.52	-35.3	0.000000	3	0.0009	11.740	
ST_ANNS_BAY	377	7866	20.22	-35.3	0.000002	42	0.0071	143.226	
	378	8128	20.90	-35.3	0.000001	14	0.0023	48.718	18
	380	6204	15.95	-35.3	0.000000	0	0.0000	0.000	
	381	5964	15.33	-35.3	0.000000	0	0.0000	0.000	
	383	5905	15.18	-35.3	0.000000	0	0.0000	0.000	
	384	5612	14.43	-35.3	0.000000	0	0.0000	0.000	
	385	5587	14.37	-35.3	0.000000	0	0.0000	0.000	
	386	4989	12.83	-35.3	0.000000	3	0.0008	10.402	
DONKIN	399	7875	14.59	-35.3	0.000000	2	0.0004	5.320	
	400	9641	17.86	-35.3	0.000000	1	0.0002	3.037	
	402	7186	13.32	-35.3	0.000000	3	0.0007	8.755	
	403	7053	13.07	-35.3	0.000001	9	0.0023	30.367	
	404	7152	13.25	-35.3	0.000000	4	0.0010	13.466	
	405	7272	13.47	-35.3	0.000001	8	0.0020	27.321	
	406	8669	16.06	-35.3	0.000001	13	0.0027	43.663	

* Foote's target strength (1987)

TABLE 2d. Daytime backscatter and biomass for Cape Breton transects (0700-1900hr).

Stratum	Transect Number	Transect Length (m)	Transect Area (km^2)	Target* Strength (dB/kg)	Sa - Area Scattering (/sr)	Total Scattering (m^2/sr)	Biomass Density (Kg/m^2)	Total Biomass (t/trans)	Set Number
MILNE	249	7347	27.23	-35.3	0.000000	4	0.0005	12.309	
	250	3002	11.13	-35.3	0.000000	1	0.0003	3.690	
MILNE_OFF	251	8416	46.78	-35.3	0.000000	0	0.0000	0.000	
	252	9078	50.46	-35.3	0.000000	0	0.0000	0.000	
	253	9287	51.63	-35.3	0.000000	7	0.0005	23.705	
	254	8023	44.60	-35.3	0.000000	4	0.0003	12.038	
WHITE_CAPE_OFF	255	9829	58.74	-35.3	0.000000	0	0.0000	0.000	
	256	10162	60.73	-35.3	0.000000	0	0.0000	0.000	
	257	9898	59.15	-35.3	0.000000	0	0.0000	0.000	
PLEASANT_BAY	276	6075	25.47	-35.3	0.000000	0	0.0000	0.000	
	277	5811	24.36	-35.3	0.000000	0	0.0000	0.000	
PLEASANT_BAY_OF	278	10310	109.85	-35.3	0.000000	0	0.0000	0.000	
	279	10329	110.05	-35.3	0.000000	0	0.0000	0.000	
	280	9465	100.85	-35.3	0.000000	0	0.0000	0.000	
	281	11002	117.22	-35.3	0.000000	0	0.0000	0.000	
LAURENTIAN-1	282	15583	72.19	-35.3	0.000000	0	0.0000	0.000	
	283	12548	58.13	-35.3	0.000000	13	0.0008	45.238	
	284	11187	51.83	-35.3	0.000000	0	0.0000	0.000	
BAY_ST_LAWRENCE	297	7714	19.30	-35.3	0.000000	0	0.0000	0.000	
LAWRENCE_OFF	298	10475	60.65	-35.3	0.000000	0	0.0000	0.000	
	299	10214	59.15	-35.3	0.000000	0	0.0000	0.000	
	300	10189	59.00	-35.3	0.000000	0	0.0000	0.000	
	301	10003	57.92	-35.3	0.000001	38	0.0022	130.319	
ASPY_OFF	302	9213	93.89	-35.3	0.000000	0	0.0000	0.000	
	303	9830	100.18	-35.3	0.000005	527	0.0178	1784.800	
	304	10091	102.84	-35.3	0.000000	0	0.0000	0.000	
	305	9665	98.50	-35.3	0.000000	0	0.0000	0.000	
ASPY_BAY	307	1934	4.34	-35.3	0.000002	8	0.0065	28.293	
	308	3374	7.56	-35.3	0.000000	0	0.0000	0.000	
	309	6459	14.48	-35.3	0.000013	187	0.0439	635.204	14
	310	9407	21.09	-35.3	0.000022	466	0.0749	1580.498	15
NEIL_HARBOUR	329	12440	35.08	-35.3	0.000000	0	0.0000	0.000	
SYDNEY_OFF	330	10426	38.64	-35.3	0.000000	0	0.0000	0.000	
	331	10351	38.36	-35.3	0.000000	0	0.0000	0.000	
	332	10326	38.27	-35.3	0.000000	0	0.0000	0.000	
	333	9927	36.79	-35.3	0.000003	94	0.0086	317.273	
NEW_WATRFRD_OFF	334	10317	40.15	-35.3	0.000004	149	0.0126	504.544	16
	336	9676	37.65	-35.3	0.000006	209	0.0188	706.572	
	337	10587	41.20	-35.3	0.000005	187	0.0154	632.969	
NEW_WATERFORD	338	7855	12.37	-35.3	0.000000	1	0.0003	3.845	
	339	7578	11.94	-35.3	0.000000	0	0.0000	0.000	
HADDOCK_BANK	358	9246	19.34	-35.3	0.000000	0	0.0000	0.000	
	359	8732	18.26	-35.3	0.000000	1	0.0002	3.815	
	360	11028	23.06	-35.3	0.000000	0	0.0000	0.000	
	361	12046	25.19	-35.3	0.000000	0	0.0000	0.000	
	362	12467	26.07	-35.3	0.000000	0	0.0000	0.000	
NEIL_HARBOR_OFF	364	9978	61.94	-35.3	0.000000	17	0.0009	57.048	
	365	13889	86.22	-35.3	0.000000	0	0.0000	0.000	
	366	8573	53.22	-35.3	0.000000	0	0.0000	0.000	
	367	8145	50.56	-35.3	0.000000	0	0.0000	0.000	
WRECK_COVE_OFF	387	12487	55.53	-35.3	0.000000	0	0.0000	0.000	
	388	12605	56.05	-35.3	0.000000	0	0.0000	0.000	
	389	13914	61.88	-35.3	0.000000	0	0.0000	0.000	
	390	13953	62.05	-35.3	0.000000	0	0.0000	0.000	
HADDOCK_OFF	391	4121	10.50	-35.3	0.000000	0	0.0000	0.000	
	392	10157	25.88	-35.3	0.000000	0	0.0000	0.000	
	393	10002	25.48	-35.3	0.000000	0	0.0000	0.000	
	394	9956	25.37	-35.3	0.000000	4	0.0006	14.741	
DONKIN_OFF	396	9860	42.63	-35.3	0.000002	88	0.0070	296.954	
	397	10172	43.98	-35.3	0.000000	0	0.0000	0.000	
	398	10150	43.89	-35.3	0.000001	29	0.0022	97.945	

* Foote's target strength (1987)

TABLE 3. 1993 backscatter and estimated biomass per strata (using Foote's (1987) target strength).

Survey Area	Stratum and Stratum Number	Target Strength (dB/kg)	Stratum Area (km^2)	Area Scattering (/sr)	Total Scattering (m^2/sr) Total	S.E.	Biomass Density (kg/m^2)	Total Biomass (tonnes/stratum) Total	S.E.	Set Number	Transect % covered at Night	Biomass % found at Night
CHALEUR INSHORE												
+0a	RIVIERE-RENARD	-35.2	86	0.000008	714	220	0.0273	2348	728		0	0
+0b	PTE SECHE	-35.2	132	0.000003	395	236	0.0099	1307	782	8,9,10	100	100
1	CAP BON AMI	-35.2	109.8	0.000000	0	0	0	0	0		71	0
2	GASPE OFFSHORE	-35.2	150	0.000000	0	0	0	0	0		0	0
3	GASPE BAY	-35.2	117.6	0.000000	4	3	0.0001	12	8		70	0
4	LA MALBAIE	-35.2	191.2	0.000000	69	57	0.0012	229	189	5,6	91	100
5	ANSE BEAUFILS	-35.2	191.9	0.000000	0	0	0	0	0		33	0
6	GRAND RIVIERE	-35.2	173.8	0.000001	88	28	0.0017	295	92		100	100
7	NEWPORT	-35.2	187	0.000000	34	17	0.0006	112	57		64	0
8	SHIGAWAKE	-35.2	323.3	0.000000	0	0	0	0	0		95	0
12	WEST MISCOU	-34.6	354	0.000014	4833	726	0.0394	13948	2094	11	79	92
+23a	EAST MISCOU NW	-35.2	524	0.000042	22240	12233	0.1405	73552	40508	3,4	88	100
+23d	EAST MISCOU SW	-35.2	524	0.000013	6722	681	0.0425	22249	2255	1,2*	75	78
CHALEUR OFFSHORE												
6a	GR RIVIERE OFF	-35.2	224	0.000000	35	29	0.0005	112	96		0	0
14	AMERICAN BANK	-35.2	187.4	0.000000	0	0	0	0	0		0	0
15	BONAVENTURE OFF	-35.2	190.9	0.000000	22	10	0.0004	76	34		0	0
16	BEAUFILS OFF	-35.2	132.6	0.000000	2	2	0.0001	13	8		0	0
17	NEWPORT OFF	-35.2	332.6	0.000000	0	0	0	0	0		0	0
18	EST CENT CHALEUR	-35.2	239.4	0.000000	0	0	0	0	0		20	0
19	CENTRAL CHALEUR	-35.2	208	0.000000	0	0	0	0	0		0	0
+23c	EAST MISCOU SE	-35.2	524	0.000001	657	155	0.0041	2146	512		0	0
+23b	EAST MISCOU NE	-35.2	524	0.000001	585	505	0.0037	1937	1673		0	0
MILNE, PEI												
24	MILNE	-35.3	187.7	0.000000	7	4	0.0001	19	12		67	0
25	MILNE OFF	-35.3	203.4	0.000000	12	7	0.0002	41	23		0	0
CAPE BRETON INSHORE												
26	WHITE CAPE	-35.3	214	0.000000	0	0	0	0	0		100	0
27	PLEASANT BAY	-35.3	281.3	0.000001	301	172	0.0036	1013	582	12,13	75	100
28	BAY ST LAWRENCE	-35.3	126.9	0.000001	80	82	0.0022	279	278		88	100
29	ASPY BAY	-35.3	168.3	0.000006	964	468	0.0195	3282	1586	14*,15*	60	23
30	NEIL HARBOUR	-35.3	259.5	0.000002	565	193	0.0074	1920	654		89	100
31	WRECK COVE	-35.3	109.7	0.000001	72	18	0.0022	241	59	17	100	100
32	ST ANNS BAY	-35.3	159	0.000000	74	42	0.0016	254	143	18	100	100
33	HADDOCK BANK	-35.3	94.9	0.000000	8	7	0.0003	29	23		29	90
34	SYDNEY	-35.3	168.6	0.000001	169	39	0.0034	573	132		100	100
35	NEW WATERFORD	-35.3	141.3	0.000000	61	29	0.0015	212	99		80	98
36	DONKIN	-35.3	109.2	0.000000	42	12	0.0013	142	40		100	100
CAPE BRETON OFFSHORE												
37	WHITE CAPE OFF	-35.3	267.7	0.000000	0	0	0	0	0		25	0
38	PLEASANT BAY OF	-35.3	456.6	0.000000	0	0	0	0	0		0	0
39	LAWRENCE OFF	-35.3	232.7	0.000000	37	38	0.0006	140	130		0	0
40	ASPY OFF	-35.3	302.2	0.000001	403	527	0.0045	1360	1785		0	0
41	NEIL HARBOUR OF	-35.3	196.6	0.000000	13	17	0.0002	39	57		0	0
+42	WRECK COVE OFF	-35.3	193	0.000000	0	0	0	0	0		0	0
+43	HADDOCK OFF	-35.3	92	0.000000	4	4	0.0002	18	15		0	0
+44	SYDNEY OFF	-35.3	151	0.000001	93	94	0.0021	317	317		0	0
+45	NEWWATERFORD OF	-35.3	159	0.000004	680	66	0.0145	2309	225		16	25
+46	DONKIN OFF	-35.3	128	0.000001	115	77	0.003	384	262		0	0
+47	LAURENTIAN-1	-35.3	231.7	0.000000	13	13	0.0002	45	45		25	0
+48	LAURENTIAN-2	-35.3	280.2	0.000000	0	0	0	0	0		100	0

\+ Additional strata since 1992 (previous years East Miscou strata subdivided)

* Sets with mackerel mixed with herring

Table 4a. Total acoustic backscattering and biomass estimates in the Southern Gulf of St. Lawrence, October 1991-1993.
Difusion acoustic totale detectee et les biomasses estimees dans le sud du golfe St.-Laurent, octobre 1991-1993.

Year	Area	Number of Transects	Proportion * covered at night	Total Scattering (m2/sr) Total	C.V.	Estimated Biomass (t/stratum)	Proportion * recorded at night
1993	CHALEUR INSHORE +	163	0.71	35099	0.35	114052	0.93
	CHALEUR OFFSHORE ++	45	0.02	1301	0.41	4284	0
	CAPE BRETON INSHORE	91	0.84	2336	0.23	7945	0.68
	CAPE BRETON OFFSHORE	39	0.18	1345	0.41	4567	0.09
						0	
	1993 TOTAL ** ***	338	0.58	40081	0.31	130848	0.85
1992	CHALEUR INSHORE	216	0.57	15337	0.10	48258	0.65
	CHALEUR OFFSHORE +++	102	0.48	31962	0.52	96582	0.75
	CAPE BRETON INSHORE	78	0.58	12077	0.25	44762	0.85
	CAPE BRETON OFFSHORE	22	0.14	22	0.69	83	0
	1992 TOTAL **	418	0.53	59377	0.29	189685	0.75
1991	CHALEUR INSHORE	158	0.59	5123	0.46	16724	0.87
	CHALEUR OFFSHORE +++	50	0.32	7133	0.55	23214	0.65
	CAPE BRETON INSHORE	49	0.61	1163	0.32	4418	0.98
	CAPE BRETON OFFSHORE	0	0	0	0.00	0	0
	1991 TOTAL	257	0.54	13419	0.33	44356	0.75

* Proportion of transects covered and biomass detected during nighttime hours, 1900 to 0700 HR. **Milne strata not included.
*** Laurentian strata not included + Includes East Miscou subdivisions NW & SW
++ Includes East Miscou subdivisions NE & SE +++ Includes East Miscou unsubdivided

Table 4b. East Miscou strata total acoustic backscattering and biomass estimates, October 1991-1993.
Difusion acoustique totale et biomasses estimees pour la strate Miscou est, octobre 1991 - 1993.

Year	Area	Number of Transects	Total Scattering (m2/sr) Total	C.V.	Estimated Biomass (t/stratum)	Percentage of Total Biomass	Percentage recorded at night
1993+	EAST MISCOU NW	8	22240	0.55	73552	56	100
	EAST MISCOU SW	8	6722	0.1	22249	17	78
	EAST MISCOU SE	8	657	0.24	2146	2	0
	EAST MISCOU NE	8	585	0.86	1937	1	0

1993+	EAST MISCOU TOTAL	@8	30204	0.41	99884	76	91
1992++	EAST MISCOU TOTAL	6	27436	0.60	88843	47	80
1991++	EAST MISCOU TOTAL	6	7030	0.56	22942	52	68

* Proportion of biomass detected during nighttime hours, 1900 to 0700 HR. ++ East Miscou undivided.
\+ East Miscou subdivided into NW , SW, SE & SW @ Mean number, distance comparable to previous years.

Table 4c. Total biomass estimates from acoustic surveys in the Southern Gulf of St. Lawrence, November 1984 - 1990.
Biomasses totales estimees lors des recensements acoustiques dans le sud du golfe St.-Laurent, novembre 1984 - 1990.

YEAR	BIOMASS ESTIMATES (tonnes)				
	EAST MISCOU**	CHALEUR TOTAL	CAPE BRETON TOTAL	CHALEUR and CAPE BRETON TOTAL	C.V. *
1990	33787	799044	135249	934293	0.275
1989***	0	11249	-	-	0.306
1988	13	240294	172886	413180	0.24
1987	107755	716733	443058	1159791	-
1986	83	255677	127708	383385	-
1985	17248	73599	106865	180464	-
1984	30091	104709	112324	217033	-

* Stratified random parallel transects within strata design implemented in 1988.
** East Miscou part of Chaleur total.
*** Partial survey only in 1989.

Table 5. Total number of transects per stratum and proportion of transects with herring backscatter for the years 1990 to 1993.

Strata number	Strata	1993 OCTOBER Number of transects	1993 OCTOBER Proportion with herring	1992 OCTOBER Number of transects	1992 OCTOBER Proportion with herring	1991 OCTOBER Number of transects	1991 OCTOBER Proportion with herring	1990 NOVEMBER Number of transects	1990 NOVEMBER Proportion with herring
CHALEUR INSHORE									
1	CAP.BON.AMI	14	0.00	6	0.50	4	0.25	4	0.25
2	GASPE.OFFSHORE	12	0.00	10	0.20	4	0.00	5	0.00
3	GASPE	10	0.10	8	0.63	10	0.50	5	0.00
4	MALBAIE	12	0.33	4	0.75	4	0.50	4	0.00
5	ANSE.BEAUFILS	12	0.00	8	0.25	6	0.17	6	0.00
6	GRANDE.RIVIERE	19	0.42	13	1.00	18	0.00	9	0.44
7	NEWPORT	14	0.29	29	0.62	20	0.50	5	0.00
8	SHIGAWAKE	19	0.00	37	1.00	34	0.79	25	0.16
9	NEW.CARLISLE	–	–	9	1.00	10	0.80	9	0.11
10	NEW.RICHMOND	–	–	23	0.61	10	0.20	10	0.50
11	MAISONNETTE	–	–	33	1.00	7	1.00	13	0.00
12	WEST.MISCOU	14	1.00	36	0.53	31	0.65	20	0.00
	INSHORE PROPORTION	**126**	**0.25**	**216**	**0.73**	**158**	**0.53**	**115**	**0.13**
CHALEUR OFFSHORE									
14	AMERICAN.BANK	2.00	–	11	0.91	4	0.25	7	0.43
17	NEWPORT.OFFSHORE	6	0.00	9	0.11	4	0.50	9	0.00
18	EAST.CENTRAL.CHALEUR	5	0.00	14	0.00	9	0.00	13	0.00
19	CENTRAL.CHALEUR	4	0.00	15	0.00	7	0.00	12	0.00
20	CARLISLE.OFFSHORE	–	–	7	1.00	4	0.25	5	1.00
21	RICHMOND.OFFSHORE	–	–	7	0.57	10	0.20	5	0.40
22	NORTH.MISCOU	–	–	9	0.56	12	0.08	9	0.33
* 23	EAST.MISCOU	32	0.81	6	0.67	6	1.00	7	0.14
	(23a - southwest) **	(8)	(1.00)						
	(23b - northwest) **	(8)	(1.00)						
	(23c - northeast)	(8)	(.38)						
	(23d - southeast)	(8)	(.88)						
	OFFSHORE PROPORTION	**49**	**0.53**	**78**	**0.40**	**56**	**0.23**	**67**	**0.21**
	CHALEUR TOTAL	**175**	**0.33**	**294**	**0.64**	**214**	**0.45**	**182**	**0.16**
CAPE BRETON INSHORE									
27	PLEASANT.BAY	8	0.25	6	0.50	4	0.25	7	0.00
29	ASPY.BAY	10	0.50	6	1.00	4	0.75	5	0.80
30	NEIL.HARBOUR	9	0.89	17	0.82	12	0.25	22	0.41
31	WRECK.COVE	8	1.00	8	0.88	6	1.00	7	0.00
32	ST.ANNS.BAY	8	0.38	4	0.25	4	0.50	9	0.00
33	HADDOCK.BANK	7	0.43	4	0.75	3	0.67	4	0.75
34	SYDNEY	8	0.88	4	1.00	3	1.00	6	0.17
35	NEW.WATERFORD	10	0.60	10	0.90	6	0.50	8	0.88
36	DONKIN	7	1.00	9	1.00	4	0.50	4	0.75
	INSHORE PROPORTION	**75**	**0.65**	**68**	**0.82**	**46**	**0.54**	**72**	**0.38**
CAPE BRETON OFFSHORE									
39	LAWRENCE.OFFSHORE	4	0.25	4	0.25	3	0.33	5	0.00
	OFFSHORE PROPORTION	4	0.25						
	CAPE BRETON TOTAL	**79**	**0.63**	**72**	**0.79**	**49**	**0.53**	**77**	**0.35**
	CHALEUR/C.BRETON TOTAL	**254**	**0.42**	**366**	**0.67**	**263**	**0.46**	**259**	**0.22**
ADDITIONAL TRANSECTS									
	CHALEUR INSHORE	21	0.33						
	CHALEUR OFFSHORE	12	0.50	24	0.33	–	–	6	0.00
	MILNE (EAST PEI)	10	0.40	8	0.25	–	–	–	–
	CAPE BRETON INSHORE	16	0.19	9	0.78	–	–	5	0.20
	CAPE BRETON OFFSHORE	35	0.26	18	0.06	4	0.00	4	0.00
	ADDITIONAL TRANS. TOTAL	**94**	**0.31**	**59**	–	**4**	–	**15**	–

* East Miscou - for 1993, subdivided into four strata

** East Miscou SW & NW are included in Chaleur Inshore biomass in Tables 3 & 4

Table 6. Total transect lengths (nm) per stratum, length (nm) having herring, and percentage thereof, for the years 1990 to 1993 (Milne strata not included)
Longueur totale des lignes (mn), longueur avec hareng detecte, et pourcentage du total, 1990 - 1993.

		1993			1992			1991			1990		
		nm	Herr. nm	%	nm	Herr. nm	%	nm	Herr. nm	%	nm	Herr. nm	%
Chaleur Inshore													
1	Cap Bon Ami	61.0	0	0	25.1	0.8	3.3	17.1	0.0	0.0	33.2	1.3	3.8
2	Gaspe Offshore	66.4	0	0	50.8	2.1	4.1	20.9	0.0	0.0	25.5	0.0	0.0
3	Gaspe Bay	28.6	0	0	27.8	3.8	13.5	30.2	3.3	10.9	20.0	0.0	0.0
4	La Malbaie	83.2	0.3	0.2	34.0	1.7	4.9	23.4	4.4	18.8	26.0	0.0	0.0
5	Anse a Beaufils	49.1	0	0	38.9	2.5	6.4	18.6	1.5	8.1	34.4	0.0	0.0
6	Grande Riviere	67.5	1.6	1.3	55.5	12.1	21.8	60.5	0.0	0.0	24.8	4.2	16.8
7	Newport	57.2	1.6	1.5	128.2	13.0	10.1	67.6	12.9	19.1	18.3	0.0	0.0
8	Shigawake	57.8	0	0	158.4	46.0	29.0	105.3	31.9	30.3	122.5	10.0	8.2
9	New Carlilse	-	-	-	25.8	3.0	11.6	29.2	9.0	30.8	23.4	1.0	4.3
10	New Richmond	-	-	-	72.3	0.0	0.0	22.2	1.4	6.3	23.2	3.0	12.9
11	Maisonette	-	-	-	89.5	23.0	25.7	16.1	6.2	38.5	35.8	0.0	0.0
12	West Miscou	71.8	14.8	11.1	17.0	14.5	85.3	25.2	23.8	94.4	98.8	0.0	0.0
	SUB TOTAL	542.7	18.3	3.4	723.3	122.4	16.9	436.3	94.4	21.6	485.9	19.4	4.0
Chaleur Offshore													
14	American Bank	10.0	0	0	14.1	5.0	35.5	14.1	0.0	0.0	28.8	2.9	10.1
19	Central Chaleur	21.1	0	0	66.0	0.0	0.0	35.2	7.6	21.6	63.7	2.0	3.1
22	North Miscou	-	-	-	64.3	3.5	5.4	25.2	0.0	0.0	48.1	8.5	17.7
23	East Miscou	219.2	47.0	11.6	95.7	25.8	27.0	84.7	5.6	6.6	88.1	2.8	3.2
	SUB TOTAL	250.3	47.0	19.6	240.1	34.3	14.3	159.2	13.2	8.3	228.7	16.2	7.1
Chaleur Offshore (Partial)													
13	Bon Ami Offshore	-	-	-	47.5	1.3	2.6	-	-	-	33.2	0.0	0.0
15	Bonaventure Offshore	16.7	1.0	3.2	33.5	4.2	12.4	-	-	-	-	-	-
16	Beaufils Offshore	15.1	0	0	32.6	1.3	3.8	-	-	-	-	-	-
17	Newport Offshore	34.6	0	0	50.7	0.0	0.0	23.7	2.9	12.2	49.9	0.0	0.0
18	E. Central Chaleur	28.1	0	0	80.9	0.0	0.0	49.7	13.3	26.8	70.6	0.0	0.0
20	Carlilse Offshore	-	-	-	57.0	3.0	5.3	36.5	0.0	0.0	39.4	16.0	40.6
21	Richmond Offshore	-	-	-	40.4	5.0	12.4	20.1	0.0	0.0	21.5	5.0	23.3
	SUB TOTAL	94.5	1.0	1.1	342.6	14.7	4.3	130.0	16.2	12.5	214.6	21.0	9.8
	CHALEUR TOTAL	887.4	66.3	7.6	1306.0	171.4	13.1	725.5	123.8	17.1	929.2	56.6	6.1
Cape Breton Inshore													
27	Pleasant Bay	31.3	2.9	5.0	21.3	2.9	13.6	18.5	0.0	0.0	25.6	0.0	0.0
28	Bay St. Lawrence	32.4	1.5	2.5	16.7	0.7	4.2	15.4	0.6	3.9	14.9	0.0	0.0
29	Aspy Bay	36.2	4.6	6.9	35.0	17.7	50.6	8.6	4.8	55.8	20.2	5.9	29.2
30	Neil Harbour	42.7	7.4	9.4	28.4	9.7	34.2	8.5	3.2	37.6	114.4	25.6	22.4
31	Wreck Cove	32.9	1.9	3.1	31.8	7.4	23.3	31.2	6.1	19.6	24.3	0.0	0.0
32	St. Ann's Bay	27.0	1.9	3.8	17.8	0.0	0.0	12.8	0.7	5.5	29.1	0.0	0.0
33	Haddock Bank	37.3	1.3	1.9	20.2	7.2	35.6	14.4	1.7	11.8	16.6	1.8	10.8
34	Sydney	43.7	5.3	6.5	18.6	3.8	20.4	17.9	6.7	37.4	43.1	5.0	11.6
35	New Waterford	44.8	1.1	1.3	52.9	5.1	9.6	25.5	4.6	18.0	31.9	5.0	15.7
36	Donkin	29.7	1.9	3.5	41.7	9.1	21.8	25.6	1.5	5.9	16.8	4.1	24.4
	SUB TOTAL	358.0	29.8	8.3	284.4	63.6	22.4	178.4	29.9	16.8	336.9	47.4	14.1
Cape Breton Inshore (Partial)													
26	White Capes	32.4	0	0	15.3	2.1	13.7	-	-	-	19.6	0.0	0.0
	SUB TOTAL	32.4	0	0	15.3	2.1	13.7				19.6	0.0	0.0
Cape Breton Offshore													
37	White Cape Offshore	20.5	0	0	22.3	0.0	0.0	-	-	-	22.8	10.7	46.9
38	Pleasant Offshore	22.1	0	0	21.6	0.0	0.0	-	-	-	-	-	-
39	Lawrence Offshore	22.1	0.6	1.5	16.7	0.0	0.0	-	-	-	-	-	-
40	Aspy Offshore	21.1	0	0	20.6	3.2	15.5	18.6	0.0	0.0	-	-	-
41	Neil Offshsore	22.1	0.6	1.5	28.4	0.0	0.0	-	-	-	-	-	-
42	Wreck Offshore	28.6	0	0	-	-	-	-	-	-	-	-	-
43	Haddock Offshore	18.4	0.4	1.2	-	-	-	-	-	-	-	-	-
44	Sydney Offshore	22.1	2.3	5.6	-	-	-	-	-	-	-	-	-
45	Waterford Offshore	22.1	7.7	18.8	-	-	-	-	-	-	-	-	-
46	Donkin Offshore	16.2	1.9	6.3	-	-	-	-	-	-	-	-	-
	SUB TOTAL	215.4	13.5	6.3	109.6	3.2	2.9	18.6	0.0	0.0	22.8	10.7	46.9
	CAPE BRETON TOTAL	573.4	43.3	7.6	394.0	66.8	17.0	197.0	29.9	15.2	177.0	42.2	23.8
	GRAND TOTAL	1460.8	109.6	7.5	1700.0	238.2	14.0	922.5	153.7	16.7	1106.2	98.8	8.9

Table 7a. Catch-at-age matrices for herring fall spawners by NAFO area from acoustic survey samples, 1990 - 1993. Values are percentage of number at age weighted by proportion of total acoustic backscatter detected per NAFO area.
Prises a l'age de harengs geniteurs d'automne par zone OPANO des releves acoustiques, 1990 - 1993.

Fall spawners NAFO 4T	AGE	1990	1991	1992	1993
	0	0.00	0.00	0.00	0.00
	1	14.40	0.57	0.00	0.00
	2	49.89	3.31	4.40	1.77
	3	21.30	27.98	2.89	22.65
	4	5.60	38.68	20.48	10.97
	5	0.00	8.71	35.74	9.33
	6	0.00	2.89	7.19	37.86
	7	0.00	1.89	2.40	7.49
	8	0.00	2.84	2.29	0.00
	9	0.00	1.63	0.86	0.43
	10	0.00	0.65	1.59	0.00
	11+	0.00	2.15	1.76	0.00
NAFO 4T Percentage of total backscatter		91.20	91.30	79.60	90.50

Fall spawners NAFO 4Vn	AGE	1990	1991	1992	1993
	0	0.00	0.00	0.00	0.00
	1	0.00	0.00	0.00	0.00
	2	0.00	0.01	0.28	0.12
	3	0.43	0.19	0.42	0.94
	4	1.68	2.18	2.12	0.85
	5	1.26	0.82	3.07	3.96
	6	1.44	1.11	1.65	1.64
	7	1.21	0.72	1.13	0.80
	8	0.60	1.67	2.45	0.29
	9	0.33	0.62	2.02	0.29
	10	0.56	0.28	1.65	0.24
	11+	1.28	1.10	5.62	0.36
NAFO 4Vn Percentage of total backscatter		8.80	8.70	20.40	9.50

Fall spawners Total NAFO 4TVn	AGE	1990	1991	1992	1993
	0	0.00	0.00	0.00	0.00
	1	14.40	0.57	0.00	0.00
	2	49.89	3.31	4.68	1.89
	3	21.74	28.16	3.31	23.60
	4	7.28	40.87	22.60	11.82
	5	1.26	9.53	38.82	13.29
	6	1.44	4.00	8.84	39.50
	7	1.21	2.61	3.53	8.29
	8	0.60	4.51	4.73	0.29
	9	0.33	2.25	2.89	0.72
	10	0.56	0.93	3.23	0.24
	11+	1.28	3.25	7.38	0.36

Table 7b. Catch-at-age matrices for herring spring spawners by NAFO area from acoustic survey samples, 1990 - 1993. Values are percentage of number at age weighted by proportion of total acoustic backscatter detected per NAFO area.
Prises a l'age de harengs geniteurs de printemps par zone OPANO des releves acoustiques, 1990 - 1993.

Spring spawners NAFO 4T	AGE	1990	1991	1992	1993
	0	0.43	0.00	0.00	0.00
	1	42.04	16.71	23.87	6.04
	2	45.50	40.42	15.62	60.63
	3	2.66	19.09	8.74	5.57
	4	0.18	6.98	21.26	10.13
	5	0.08	1.91	4.74	8.14
	6	0.23	0.90	2.40	0.00
	7	0.00	1.45	0.87	0.00
	8	0.00	1.03	0.95	0.00
	9	0.08	1.38	0.53	0.00
	10	0.00	0.47	0.64	0.00
	11+	0.00	0.94	0.00	0.00
NAFO 4T Percentage of total backscatter		91.20	91.29	79.60	90.50

Spring spawners NAFO 4Vn	AGE	1990	1991	1992	1993
	0	0.00	0.00	0.00	0.00
	1	0.12	0.00	4.78	1.27
	2	1.59	2.73	4.85	4.37
	3	0.26	1.89	5.42	1.13
	4	2.92	0.00	2.14	0.51
	5	1.16	0.00	0.00	0.00
	6	0.33	4.08	1.04	2.18
	7	1.61	0.00	0.00	0.00
	8	0.00	0.00	0.00	0.00
	9	0.47	0.00	2.17	0.00
	10	0.34	0.00	0.00	0.00
	11+	0.00	0.00	0.00	0.00
NAFO 4Vn Percentage of total backscatter		8.80	8.70	20.40	9.46

Spring spawners Total NAFO 4TVn	AGE	1990	1991	1992	1993
	0	0.43	0.00	0.00	0.00
	1	42.15	16.71	28.65	7.32
	2	47.09	43.15	20.47	64.99
	3	2.93	20.98	14.16	6.70
	4	3.10	6.98	23.40	10.63
	5	1.24	1.91	4.74	8.14
	6	0.56	4.98	3.44	2.18
	7	1.61	1.45	0.87	0.00
	8	0.00	1.03	0.95	0.00
	9	0.55	1.38	2.70	0.00
	10	0.34	0.47	0.64	0.00
	11+	0.00	0.94	0.00	0.00

Table 8. Average weight (kg) at age for fall and spring spawning herring by NAFO area, acoustic surveys 1988-1993
Poids moyen (kg) a l'age des harengs geniteurs d'automne et printemps, par zone d'OPANO, releves acoustiques 1988-1993

FALL SPAWNERS
NAFO 4T

AGE	1988	1989	1990	1991	1992	1993
1	0.029	--	0.038	0.028	--	--
2	0.097	0.093	0.085	0.088	0.070	--
3	0.156	0.145	0.136	0.138	0.131	0.073
4	0.209	0.159	0.162	0.177	0.170	0.116
5	0.242	0.208	--	0.203	0.192	0.142
6	0.277	--	--	0.241	0.222	0.192
7	0.296	--	--	0.272	0.244	0.203
8	0.362	--	--	0.305	0.287	0.227
9	0.352	--	--	0.307	0.264	--
10	--	--	--	0.336	0.303	0.306
11+	0.433	--	--	0.374	0.334	--

NAFO 4Vn

AGE	1988	1989	1990	1991	1992	1993
1	0.038	--	--	--	--	--
2	0.101	--	--	0.109	0.069	0.077
3	0.165	--	0.173	0.166	0.131	0.130
4	0.209	--	0.208	0.202	0.180	0.160
5	0.236	--	0.225	0.228	0.210	0.186
6	0.239	--	0.271	0.244	0.241	0.214
7	0.268	--	0.292	0.285	0.238	0.246
8	0.303	--	0.300	0.310	0.292	0.258
9	0.325	--	0.333	0.342	0.305	0.307
10	0.300	--	0.349	0.331	0.327	0.319
11+	0.367	--	0.349	0.357	0.349	0.335

SPRING SPAWNERS
NAFO 4T

AGE	1988	1989	1990	1991	1992	1993
0	0.021	--	0.023	--	--	--
1	0.081	0.079	0.064	0.082	0.061	0.069
2	0.123	0.115	0.104	0.132	0.087	0.110
3	0.196	0.157	0.138	0.167	0.157	0.130
4	0.194	--	0.233	0.210	0.195	0.173
5	0.257	--	0.253	0.237	0.225	0.222
6	0.327	--	0.235	0.297	0.249	--
7	0.366	--	--	0.294	0.238	--
8	0.353	--	--	0.376	0.403	--
9	--	--	0.317	0.357	0.317	--
10	--	--	--	0.319	0.350	--
11+	--	--	--	0.447	--	--

NAFO 4Vn

AGE	1988	1989	1990	1991	1992	1993
0	0.027	--	--	--	--	--
1	0.081	--	0.070	--	0.065	0.070
2	0.145	--	0.137	0.157	0.099	0.132
3	0.200	--	0.156	0.175	0.144	0.133
4	0.218	--	0.244	--	0.237	0.169
5	--	--	0.225	--	--	--
6	0.338	--	0.207	0.276	0.249	0.292
7	--	--	0.325	--	--	--
8	0.376	--	--	--	--	--
9	0.376	--	0.372	--	0.309	--
10	--	--	0.390	--	--	--
11+	--	--	--	--	--	--

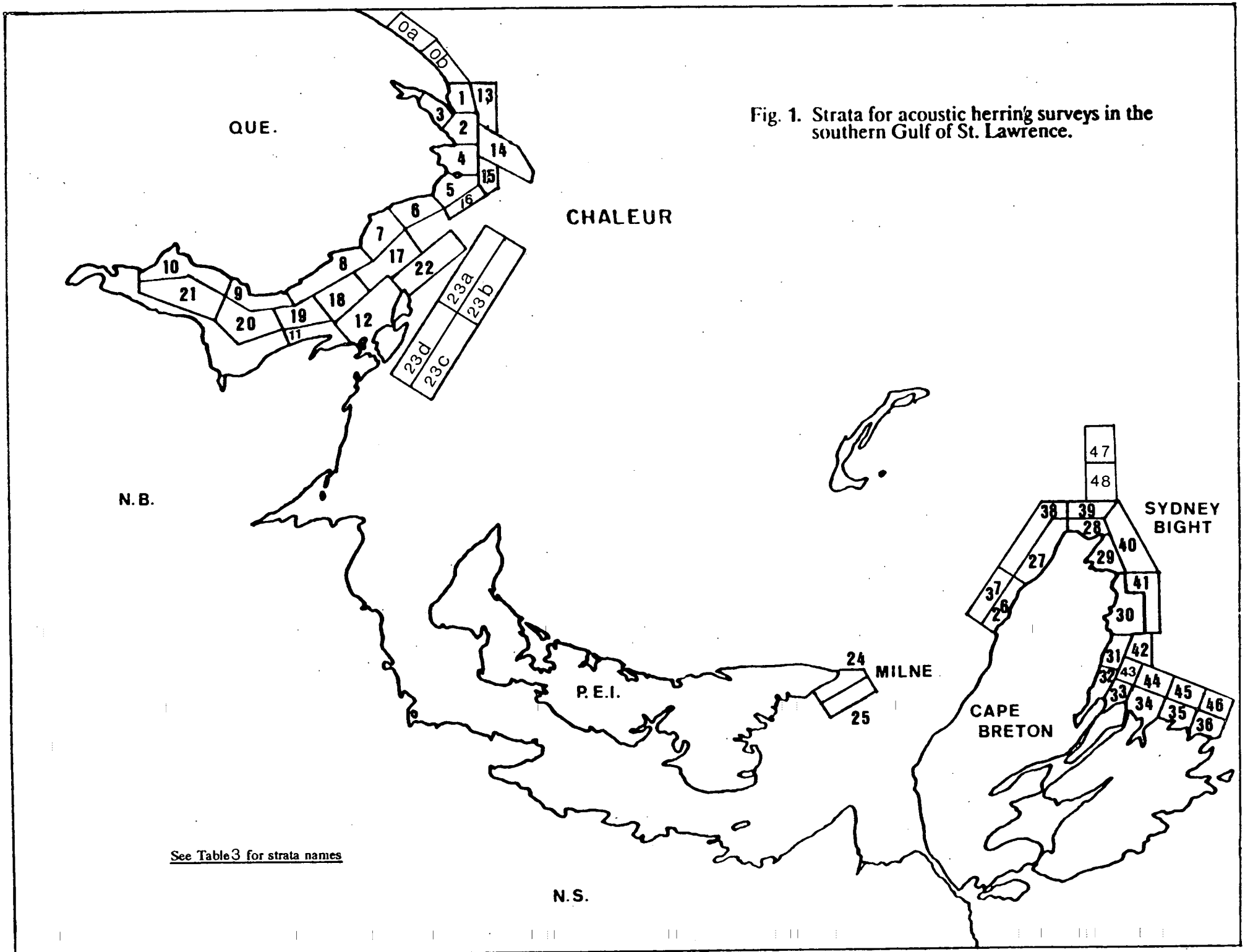
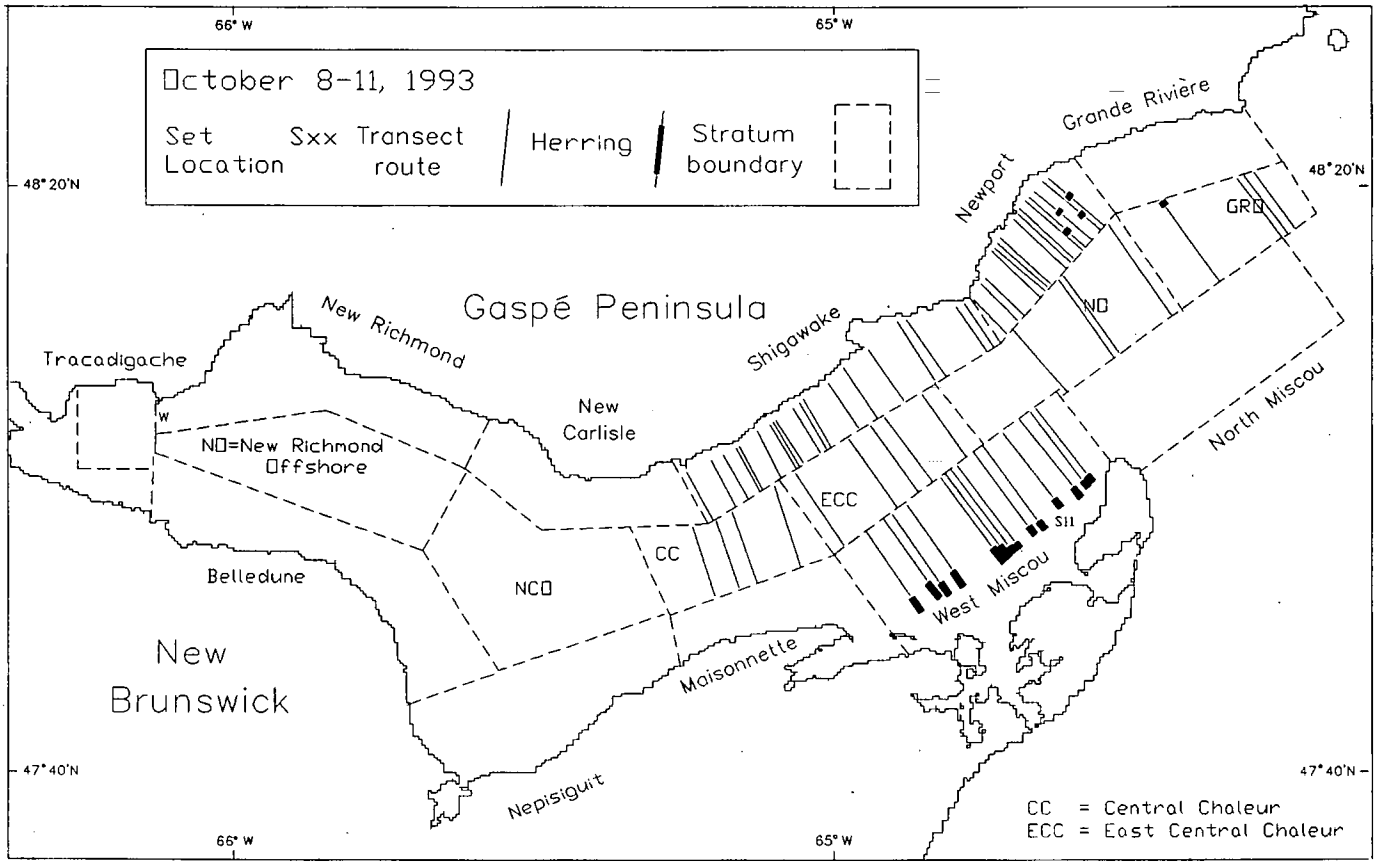
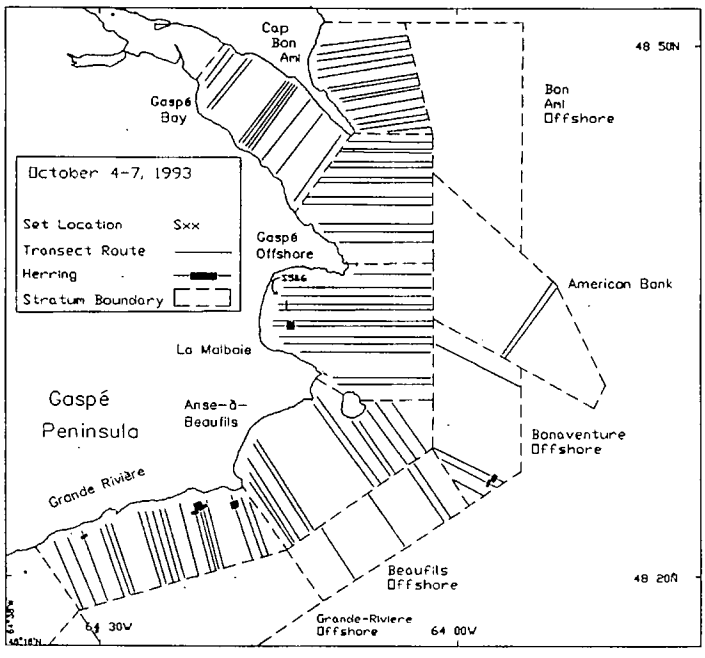


Fig. 1. Strata for acoustic herring surveys in the southern Gulf of St. Lawrence.





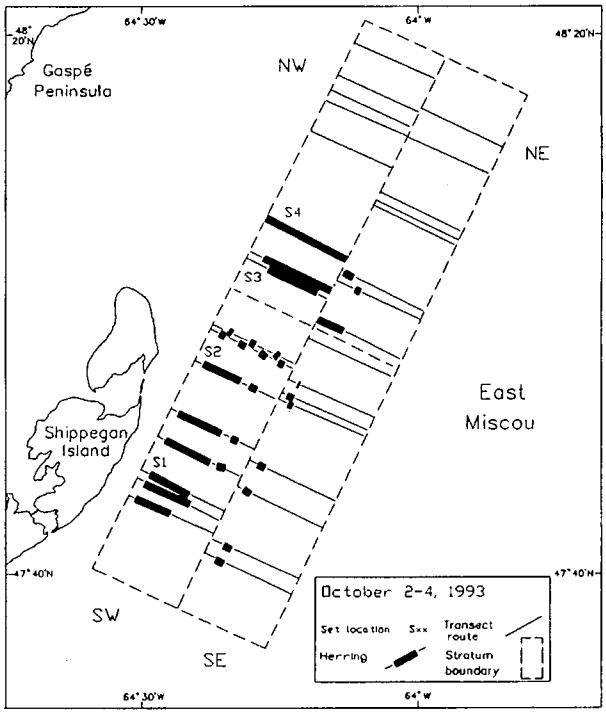


Fig 2. Acoustic transects, herring distribution and set locations - Chaleur Bay, Gaspe and East Miscou. N193 cruise, 1993

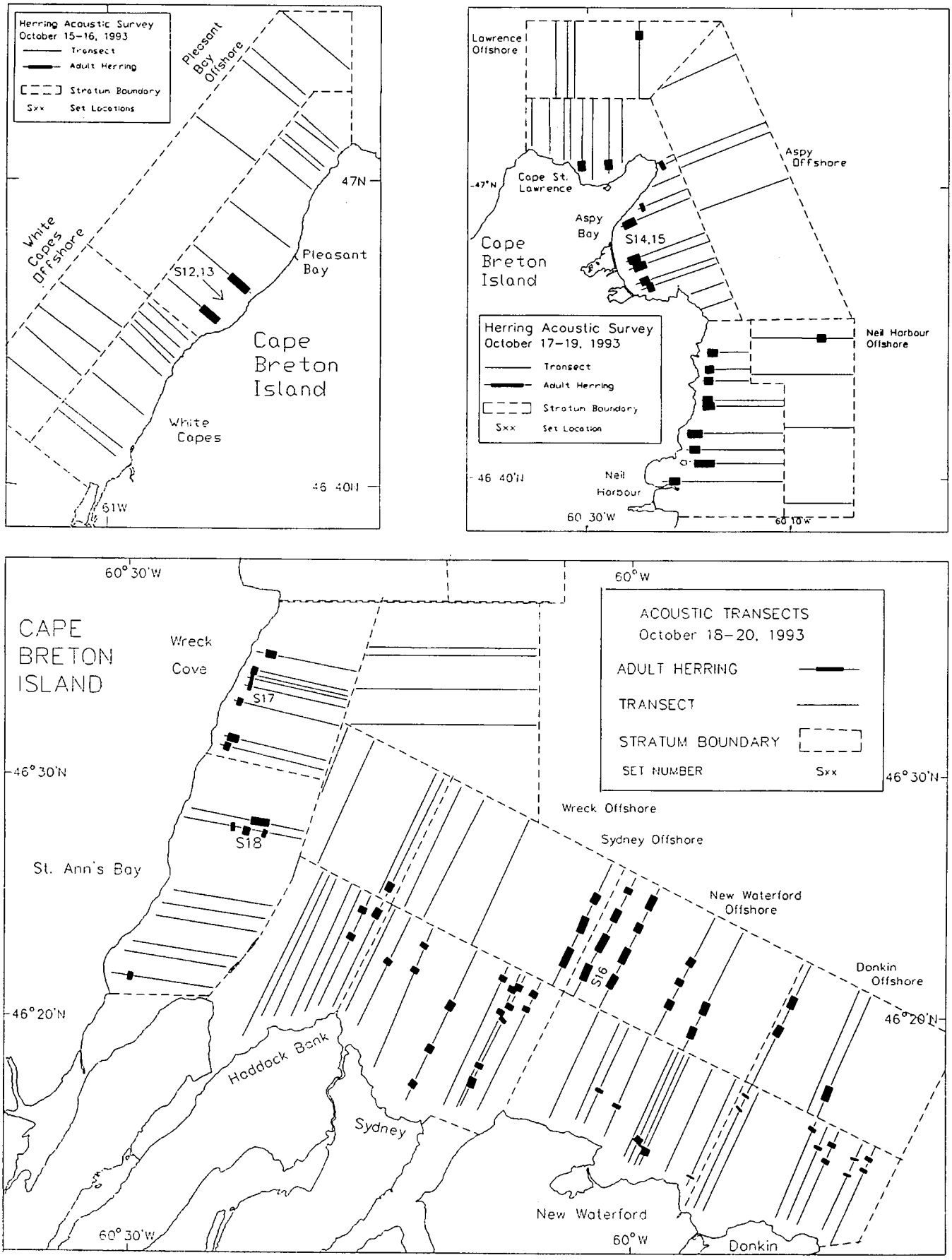


Fig. 3. Acoustic transects, herring distribution, and set locations – Cape Breton. N193 cruise, 1993.

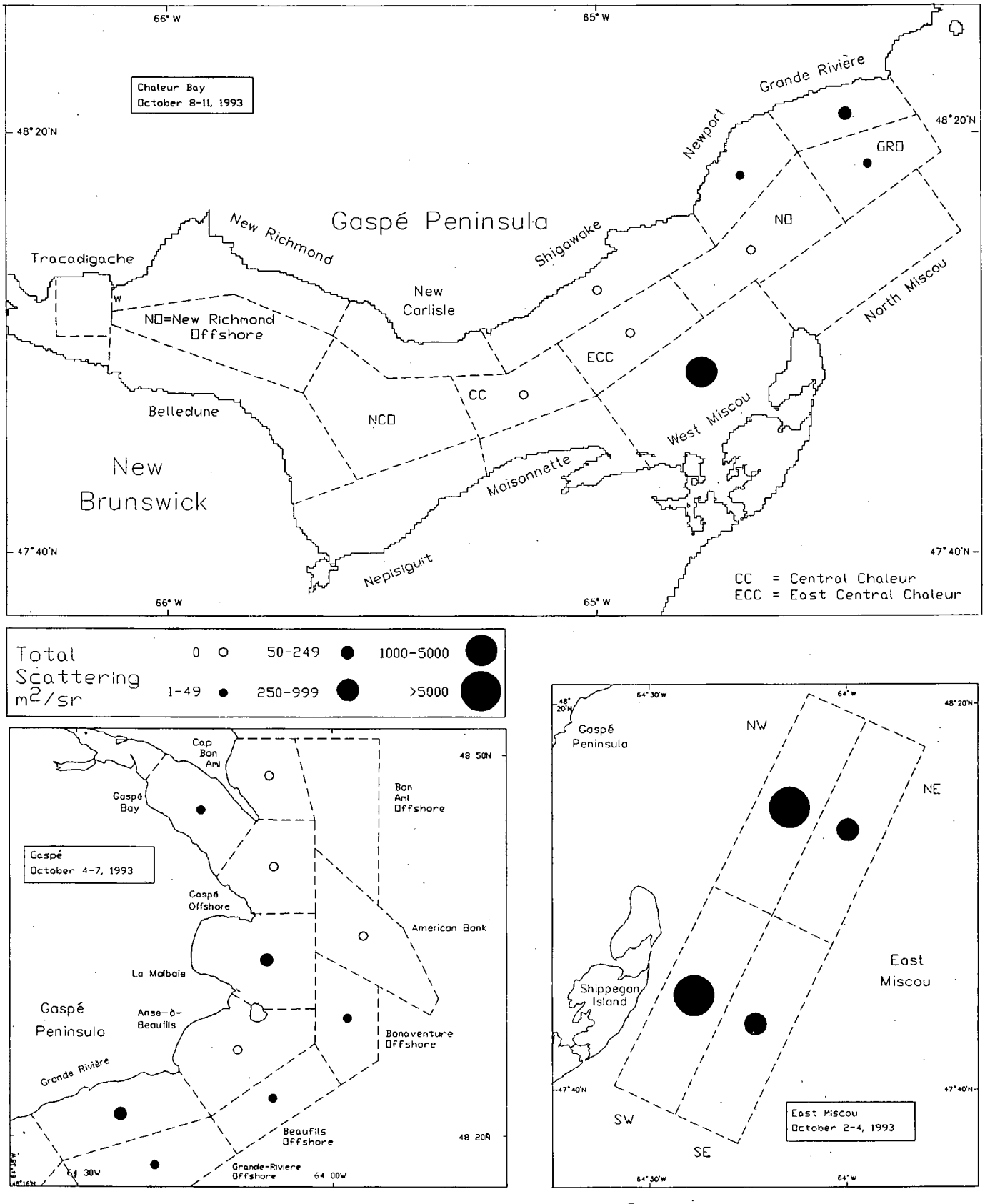


Fig. 4. Total acoustic scattering (m^2/sr) by herring distributed in Chaleur Bay, Gaspé and East Miscou. N193 cruise, 1993.

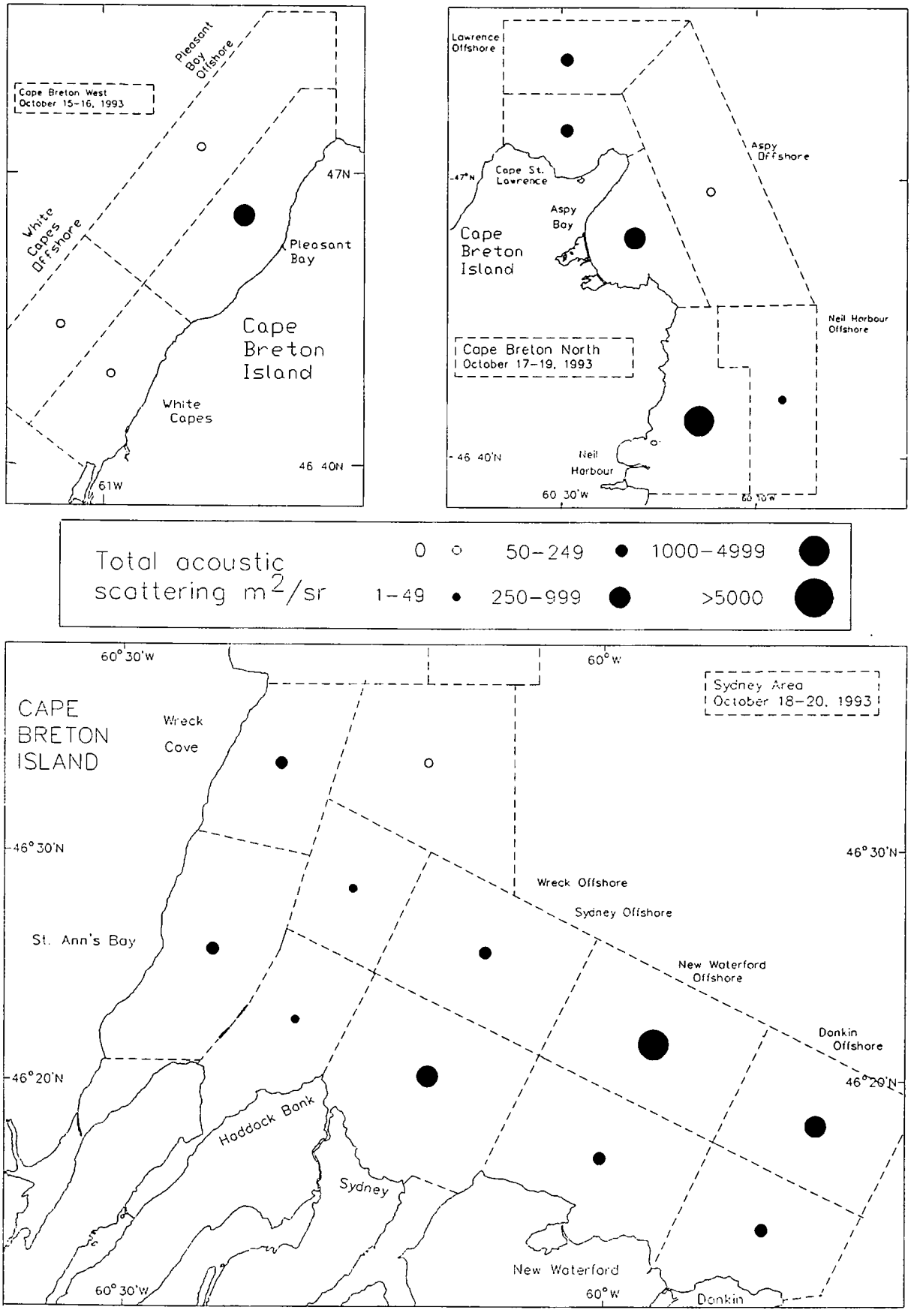


Fig **5**. Total acoustic scattering (m^2/sr) by herring in Cape Breton region. N193 cruise, 1993.

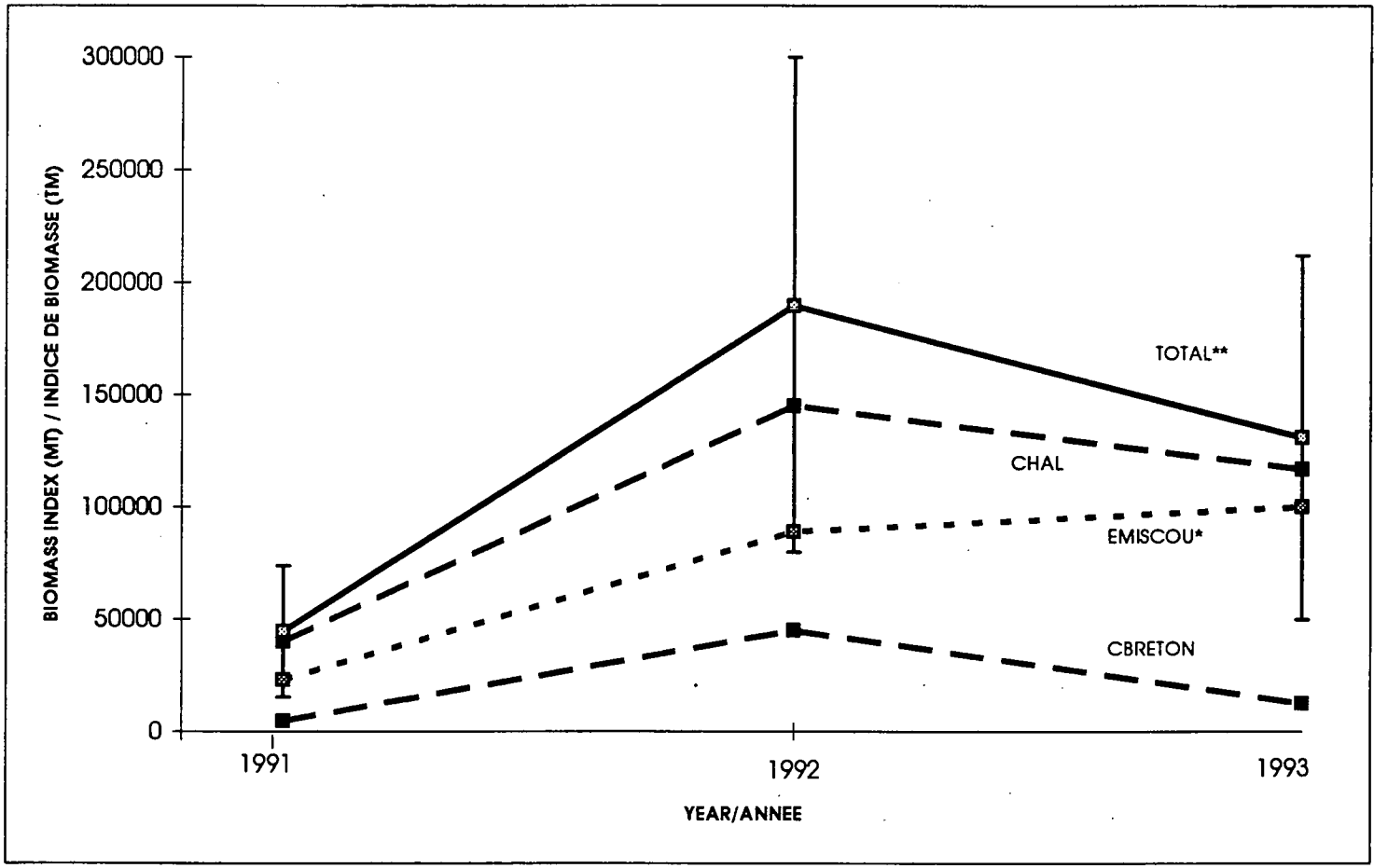


Figure 6. Total and by area biomass estimates, October acoustic surveys, 1991 - 1993.
Estimes de biomasse totale et par region, releves acoustiques d'octobre, 1991 - 1993.
(Bars are +/- 2 standard errors of TOTAL estimate) (Lignes sont +/- 2 erreurs standards du TOTAL)

* East Miscou (EMISCOU) part of Chaleur (CHAL) total ** TOTAL is the sum of Chaleur (CHAL) plus Cape Breton (CBRETON)

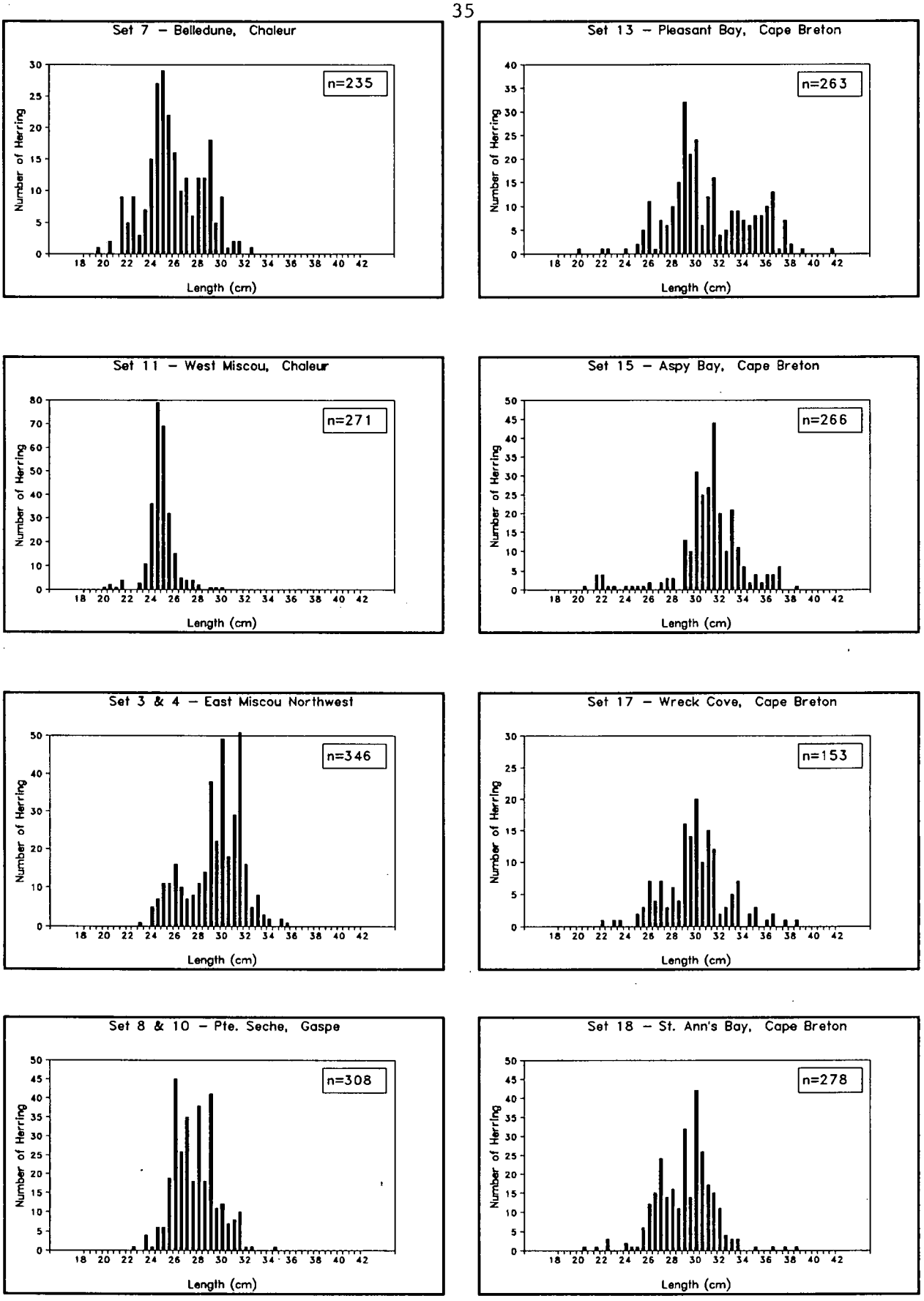


Figure 7. 1993 length frequencies of herring in acoustic survey N193 sets from Chaleur Bay, East Miscou, Gaspe and Cape Breton. See figs 2 and 3 for set locations.

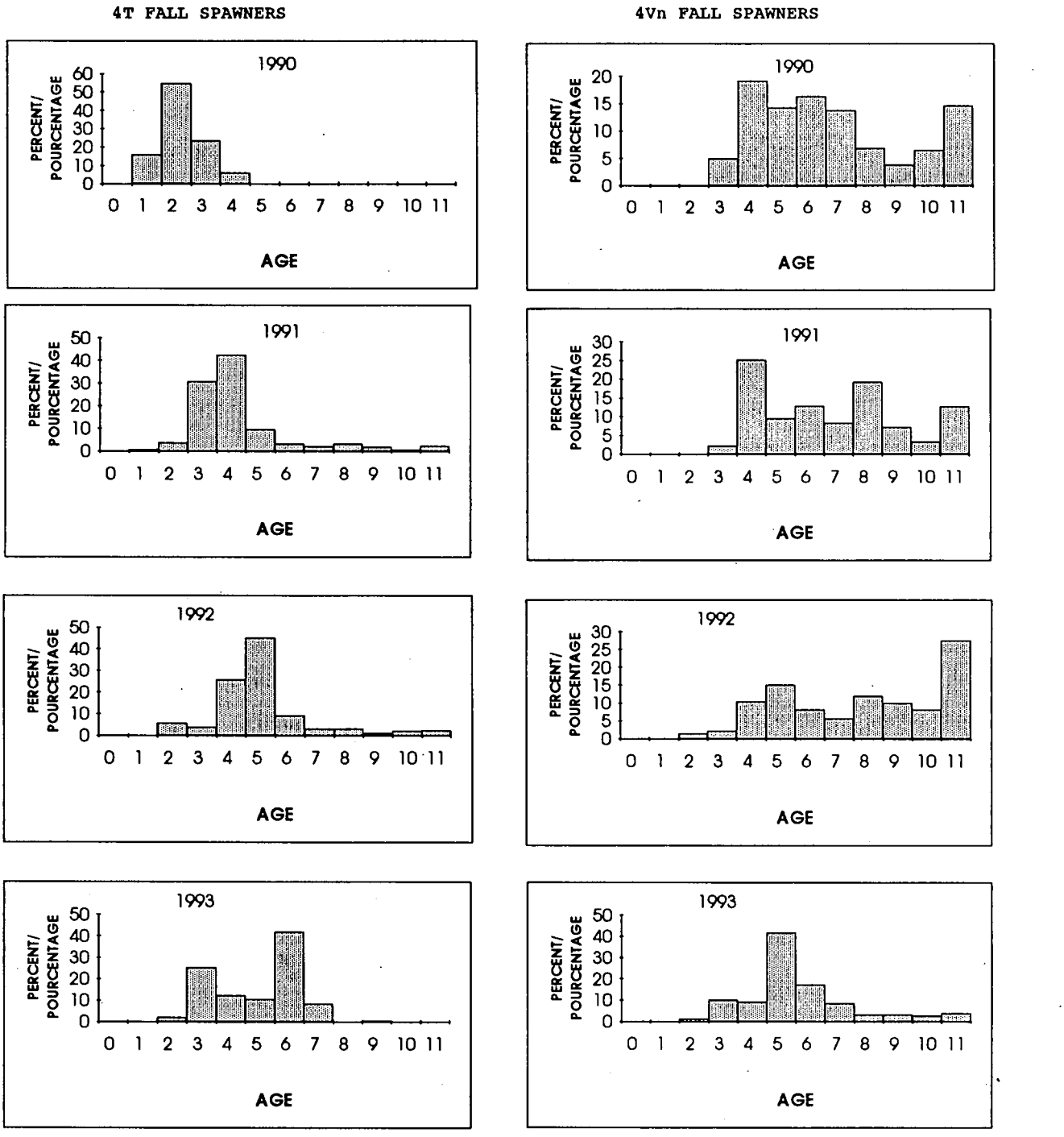


Fig. 8a. Percent numbers at age of fall spawners in acoustic survey samples.
Pourcentage de nombres a l'age provenant des releves acoustiques

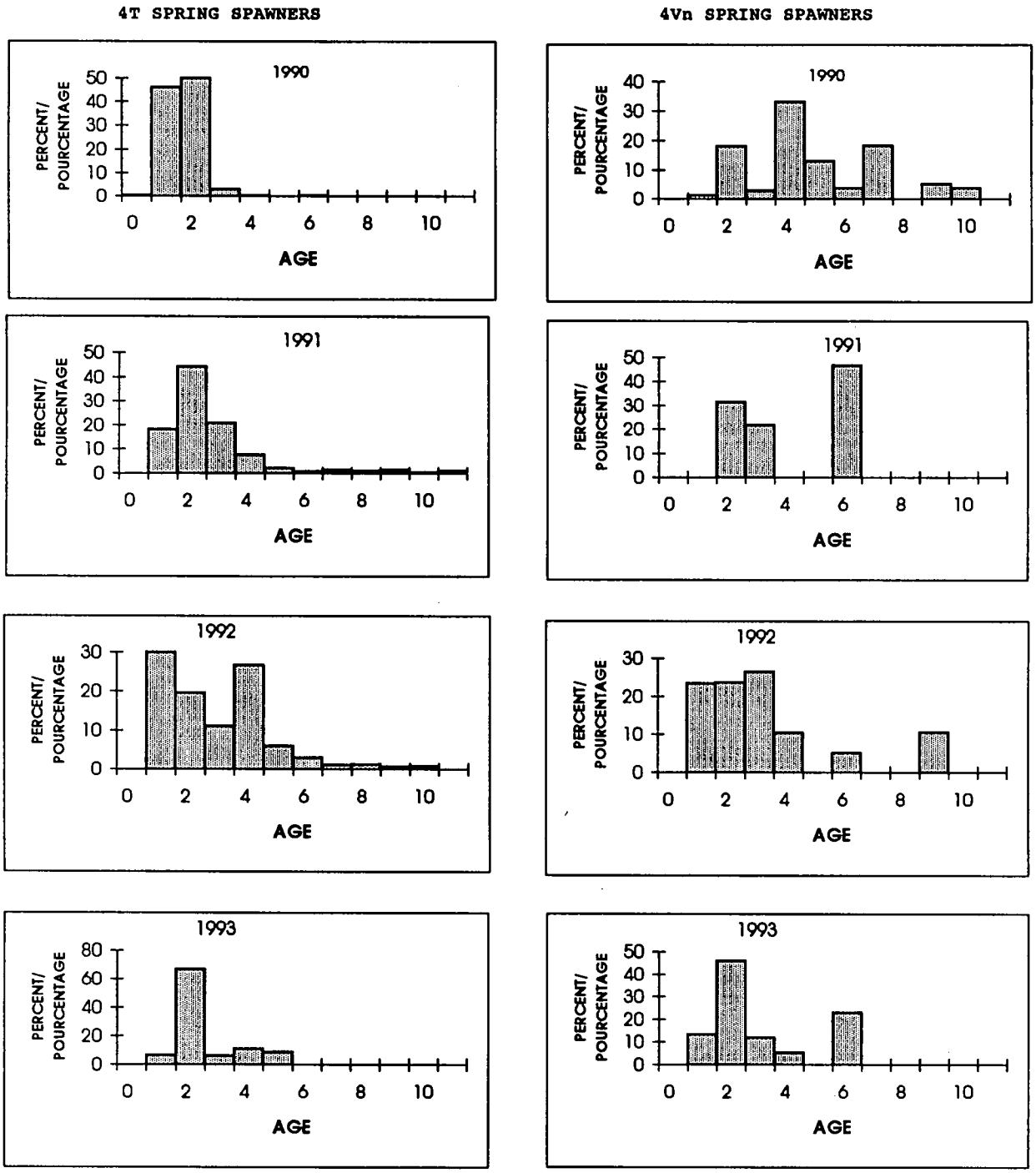


Fig. 8b. Percent numbers at age of spring spawners in acoustic survey samples.
Pourcentage de nombres a l'age, geniteurs du printemps, releves acoustique

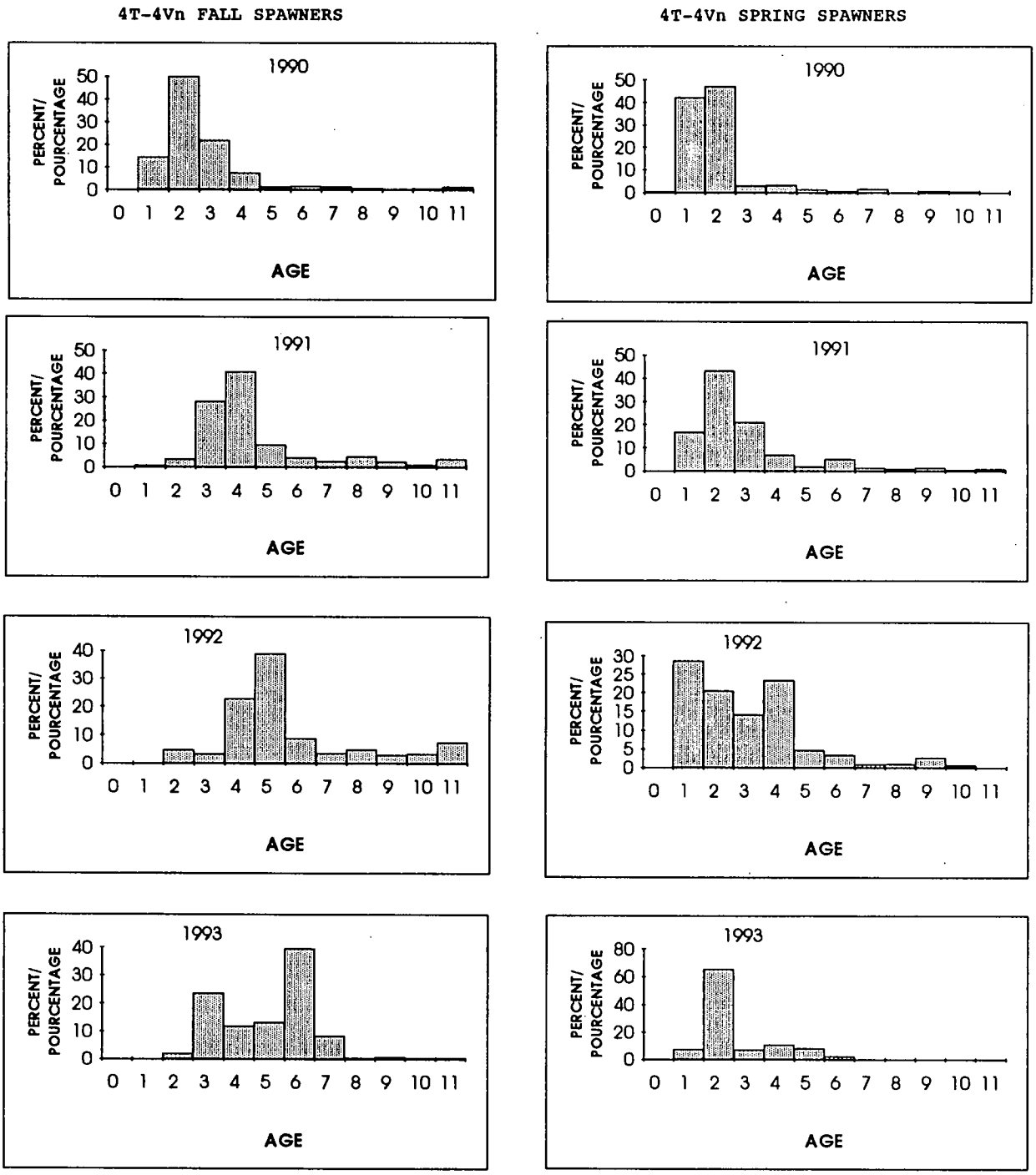


Fig. 8c. 4T-4Vn Percent numbers at age of fall and spring spawners in acoustic survey samples, weighted by proportion of backscatter recorded per area.
Pourcentages a l'age des geniteur printemps et automne, 4T 4Vn combines.

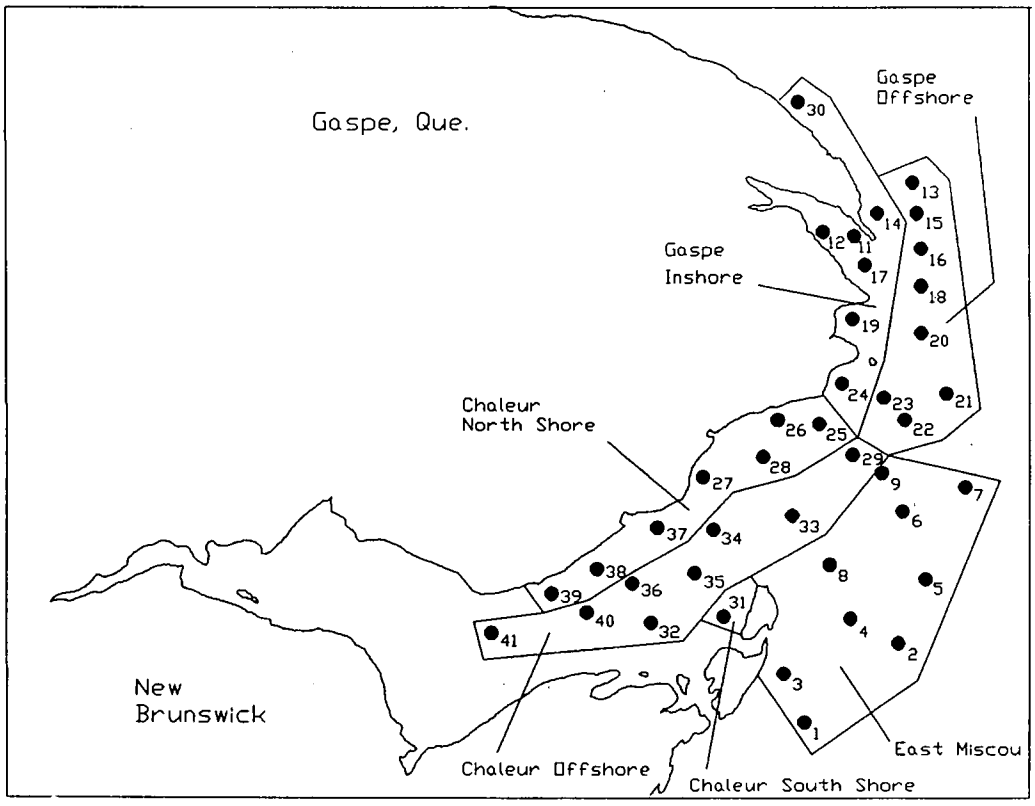


Fig. 9a. 1993 N193 CTD locations for Chaleur, East Miscou and Gaspe. Adult herring cruise.

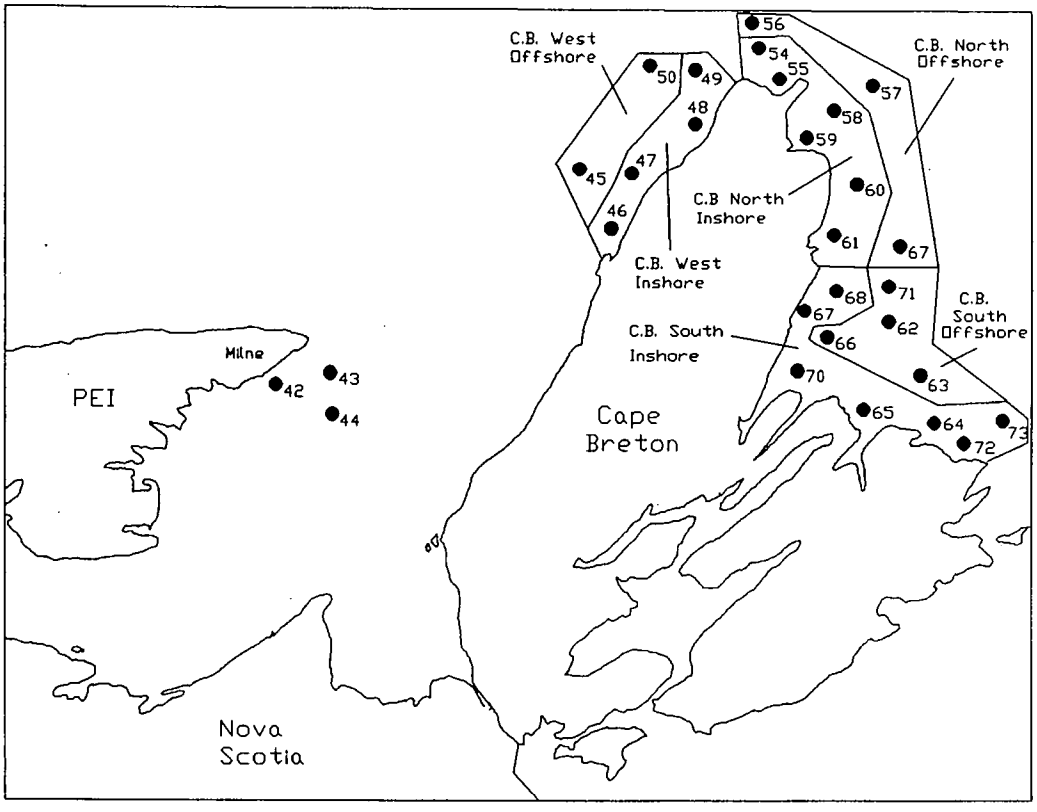
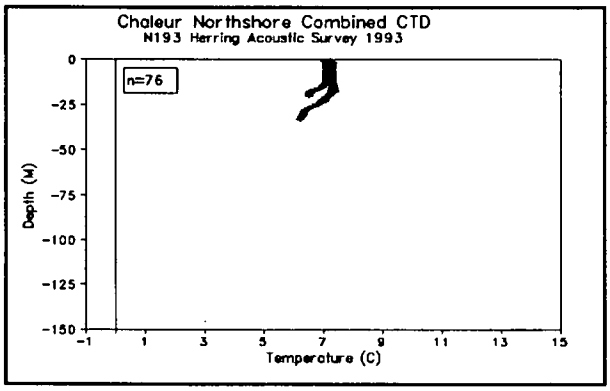
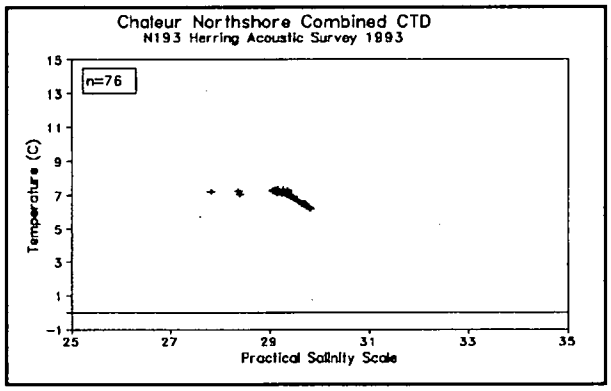
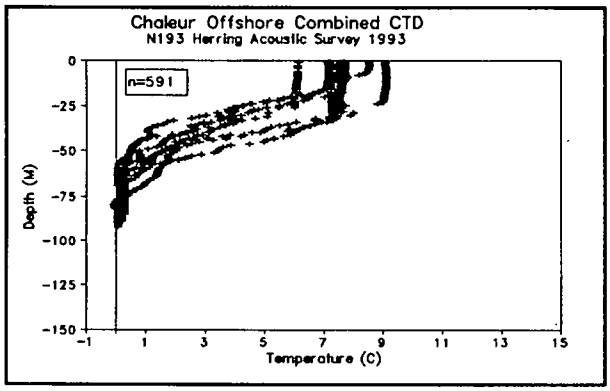
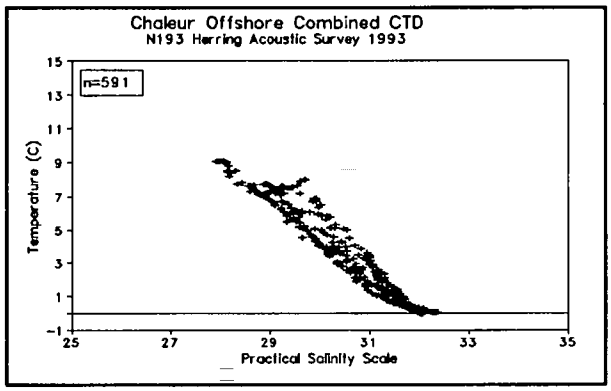


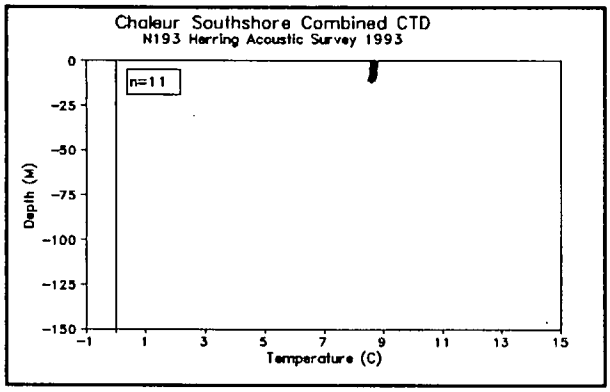
Fig 9b. 1993 N193 CTD locations for Milne, and Cape Breton West, North and South. Adult herring cruise.

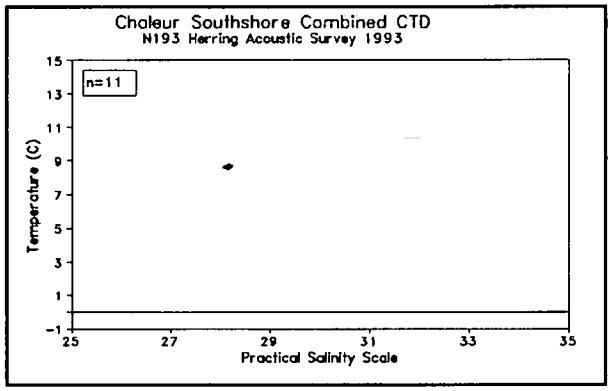


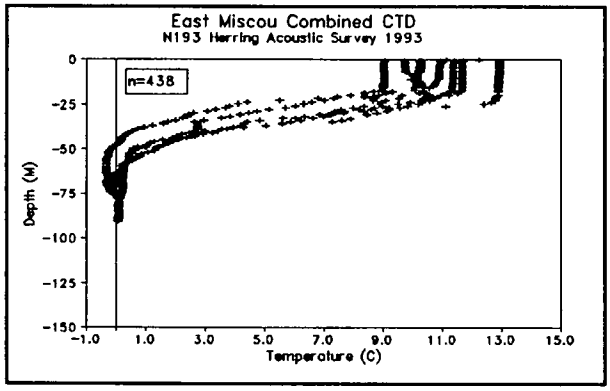












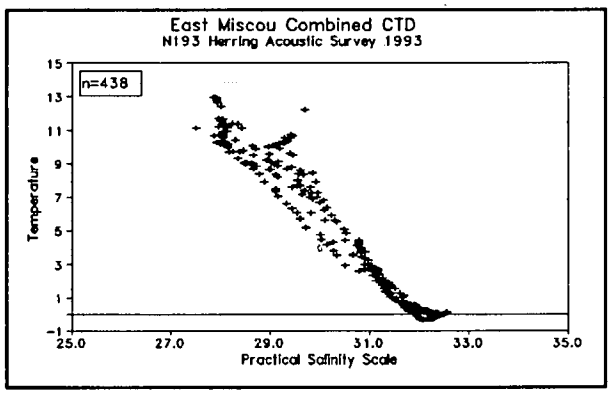
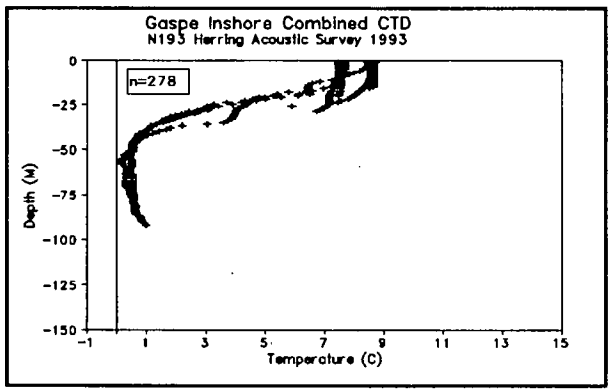
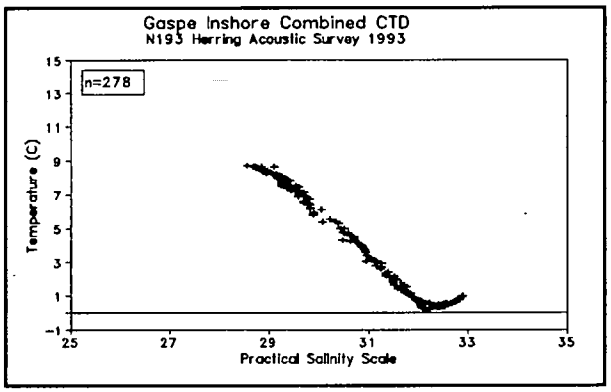
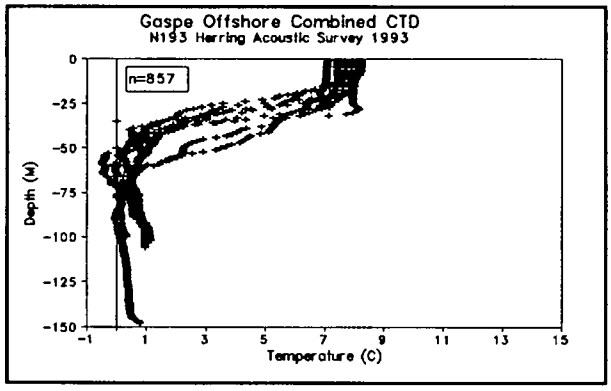
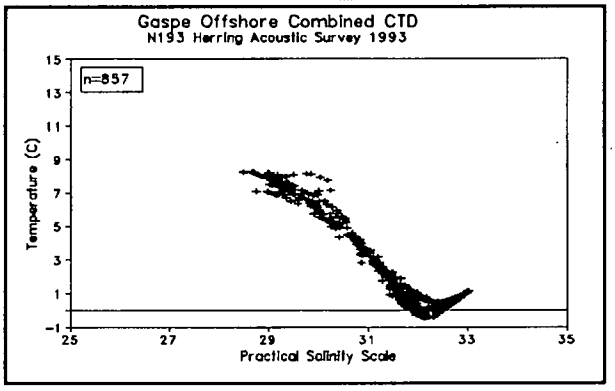


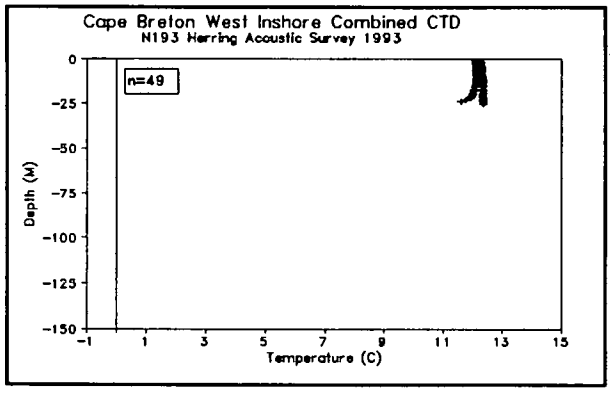
Figure 10a. N193 October 1993 herring acoustic survey combined depth, temperature and salinity data for Chaleur north-, off- and south-shore, and for East Miscou.

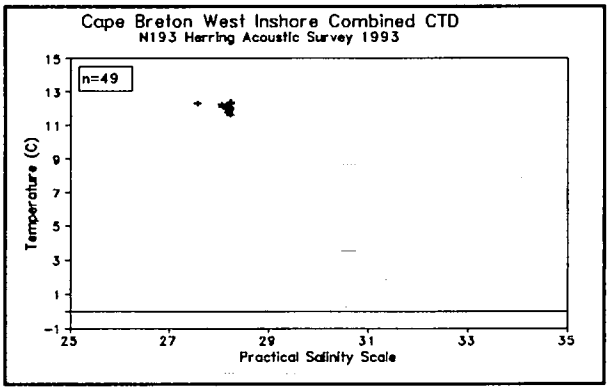


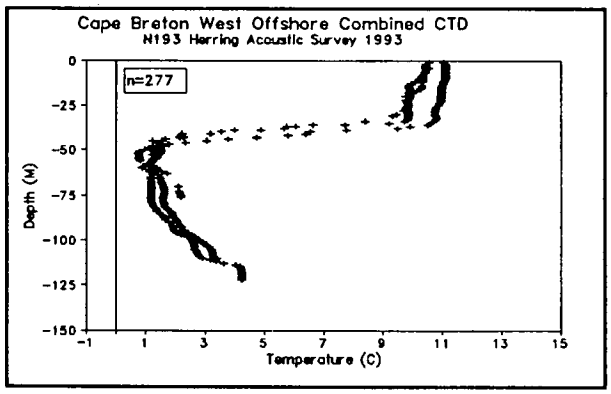












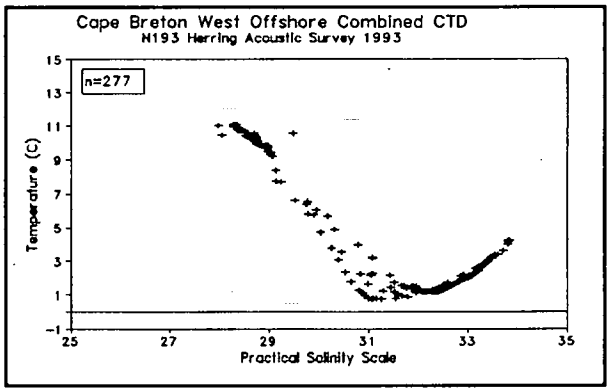
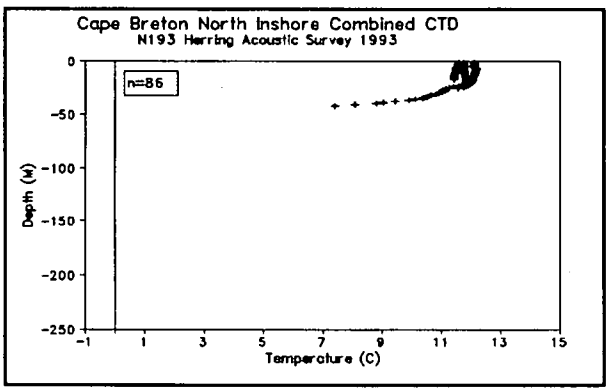
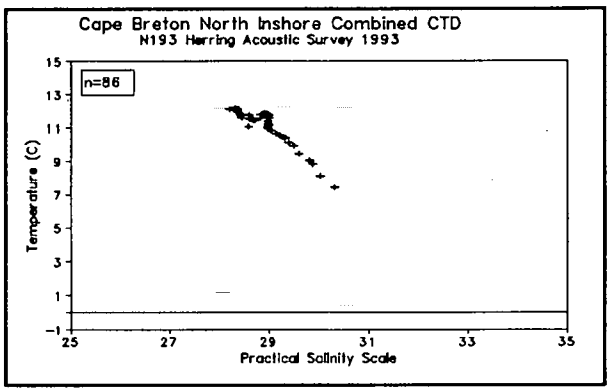
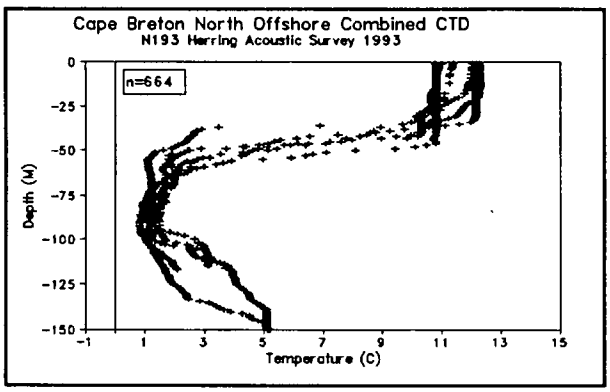
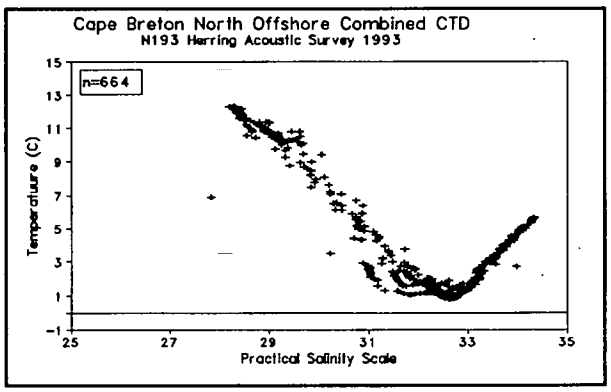


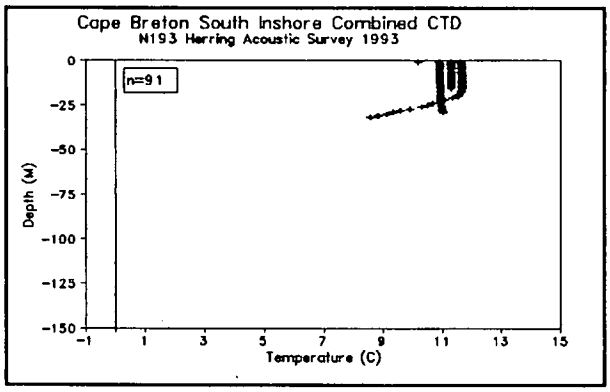
Figure 10b. N193 October 1993 herring acoustic survey combined depth, temperature and salinity data for Gaspe and Cape Breton west, inshore and offshore.

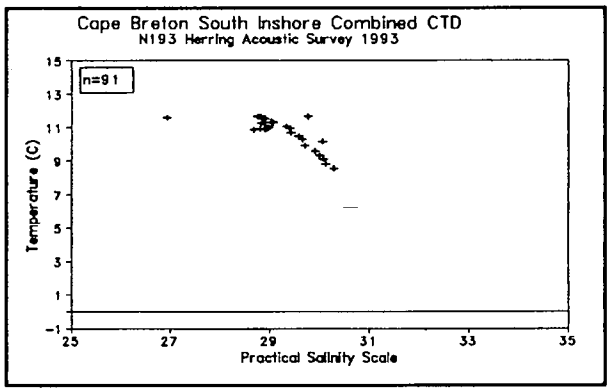


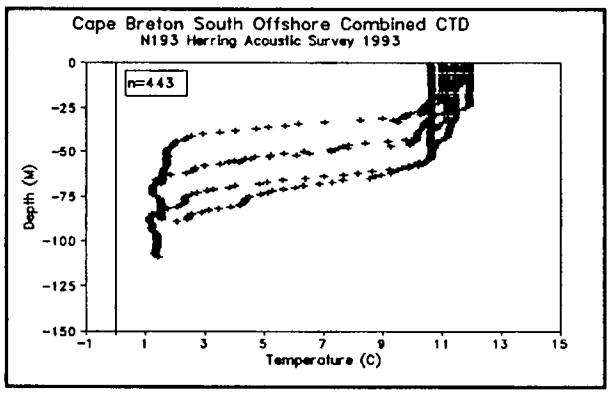












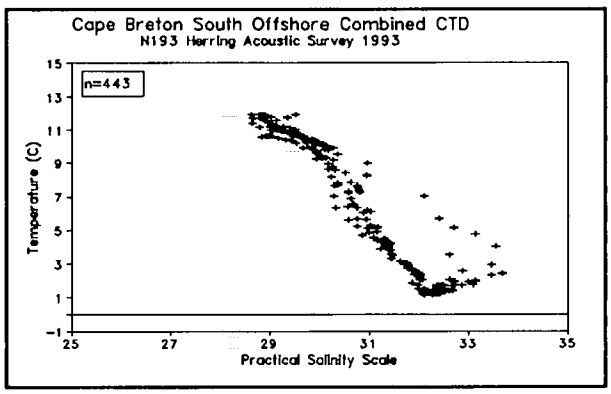


Figure 10c. N193 October 1993 herring acoustic survey combined depth, temperature and salinity data for Cape Breton north and south, inshore and offshore.

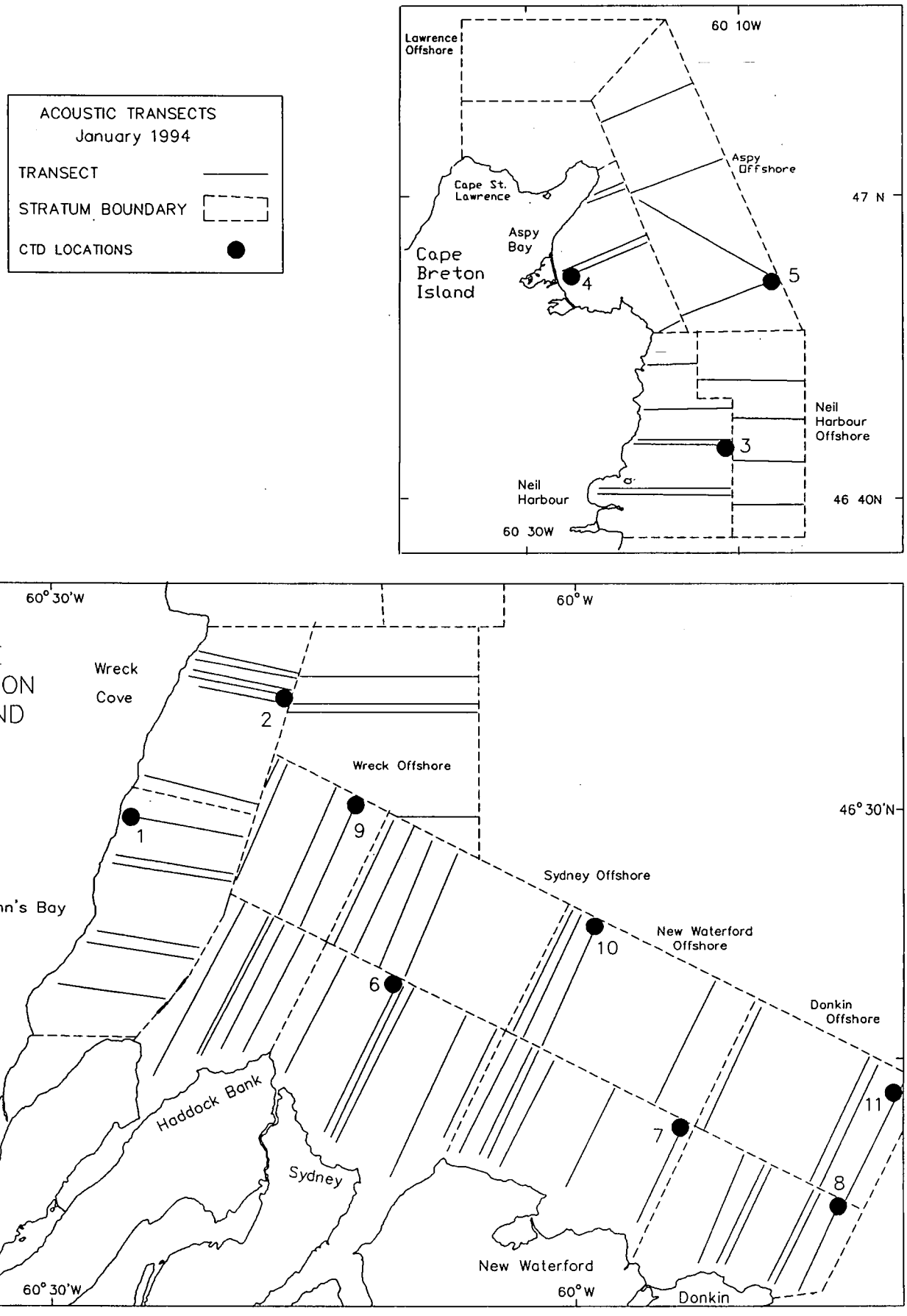


Fig. **11a** N197 January 1994 herring acoustic survey transects and CTD locations.

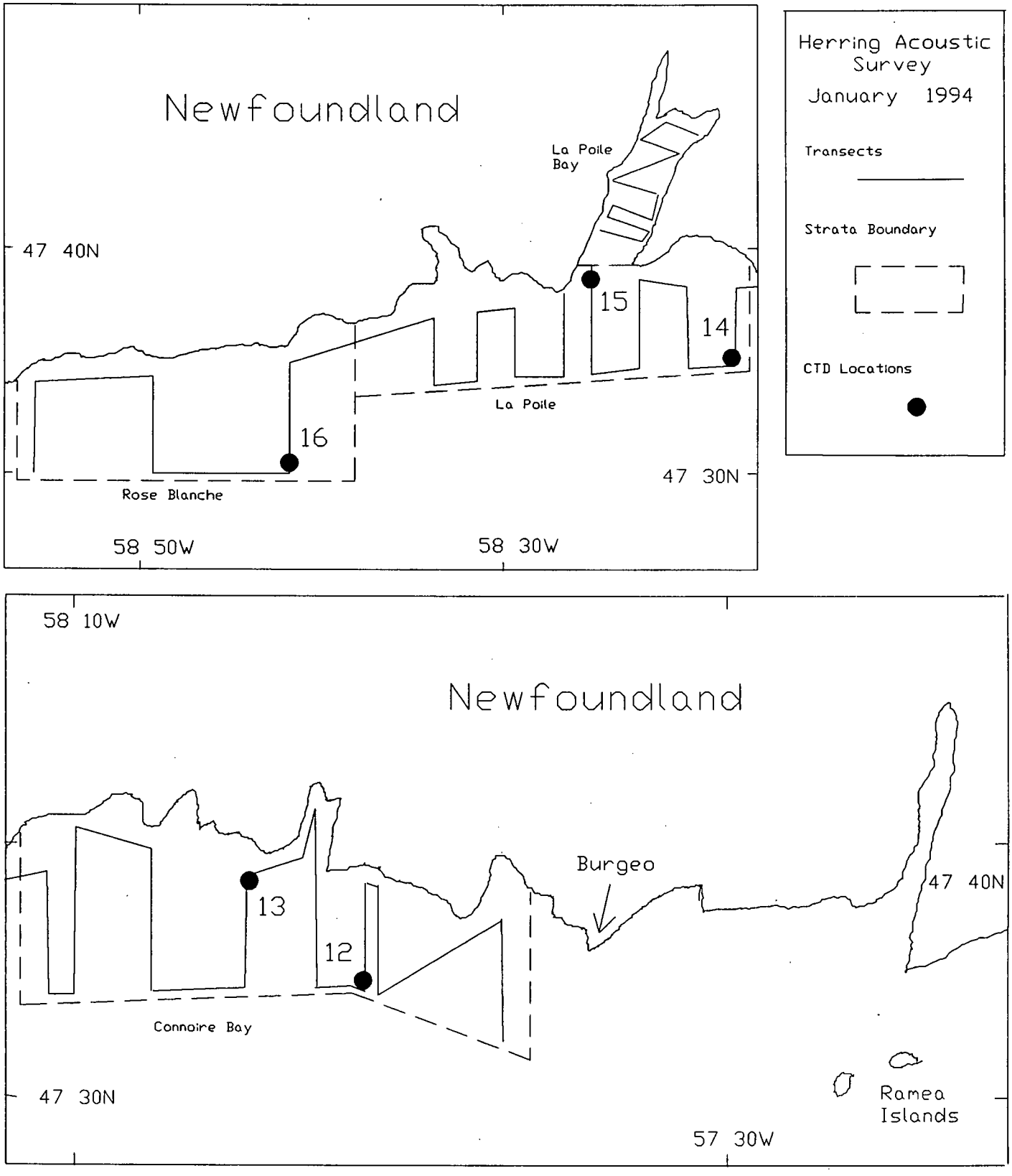
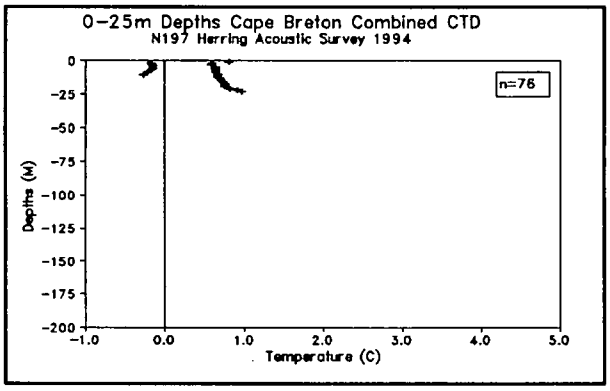
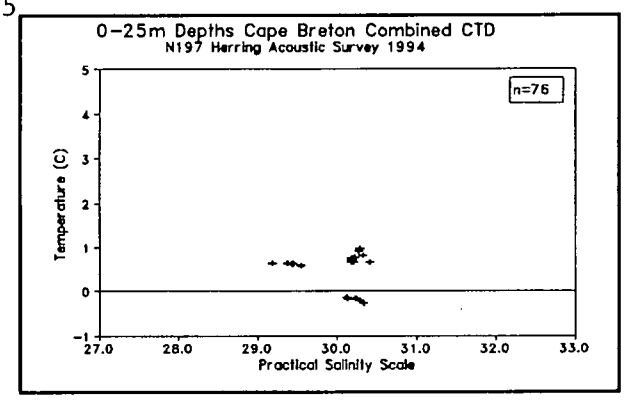
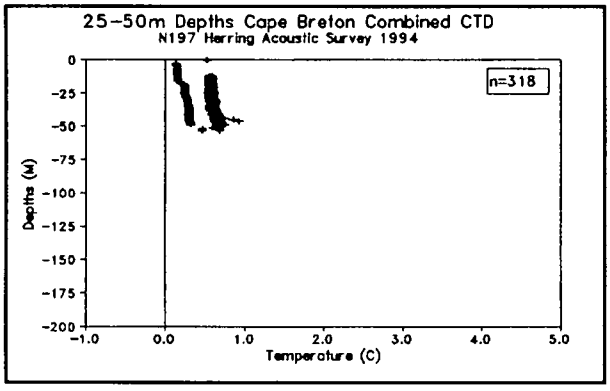
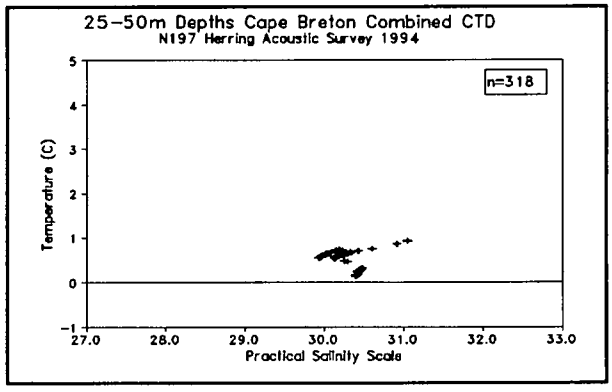


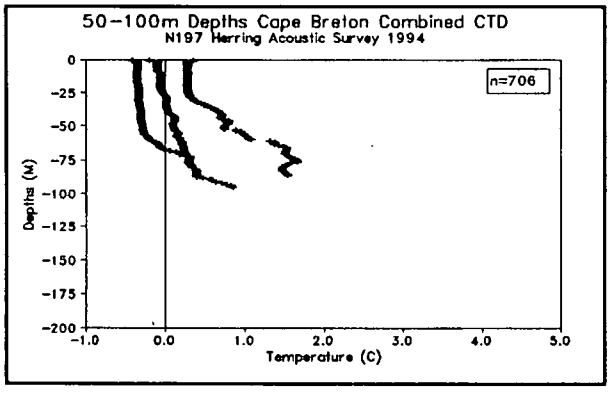
Fig. 11b. N197 January 1994 herring acoustic survey transects and CTD locations. South coast Newfoundland.

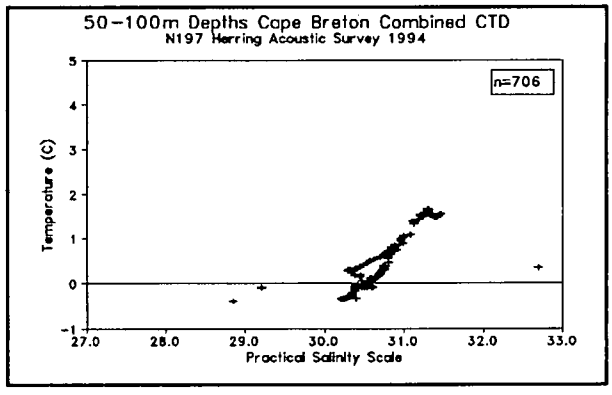


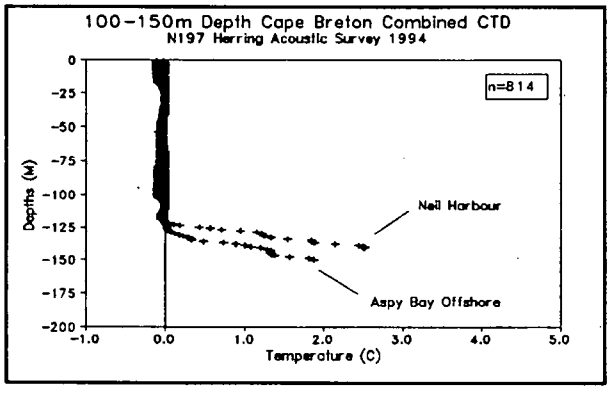












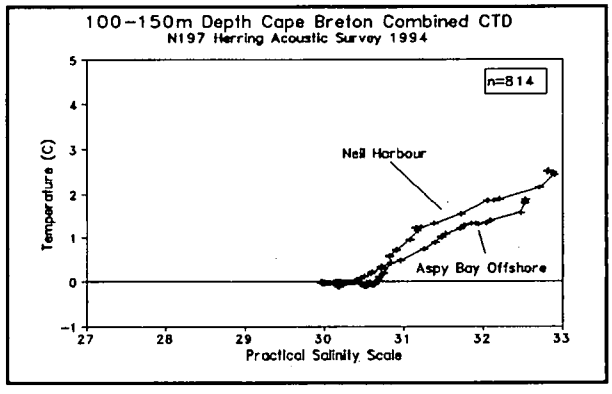
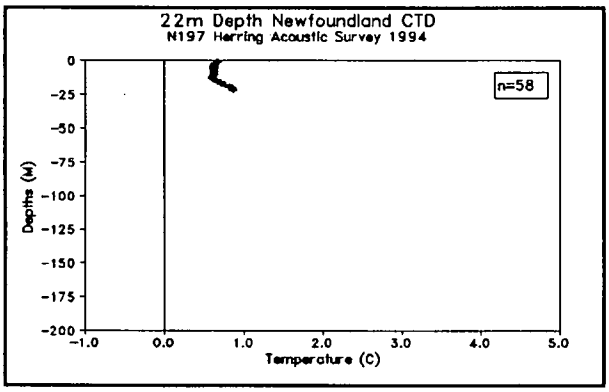
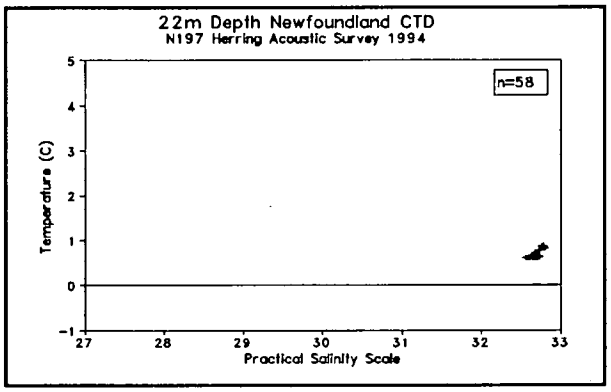
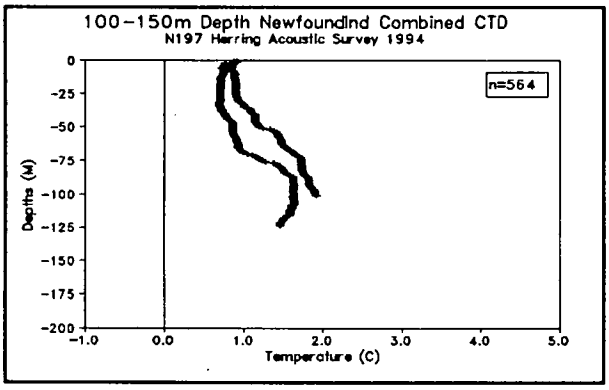
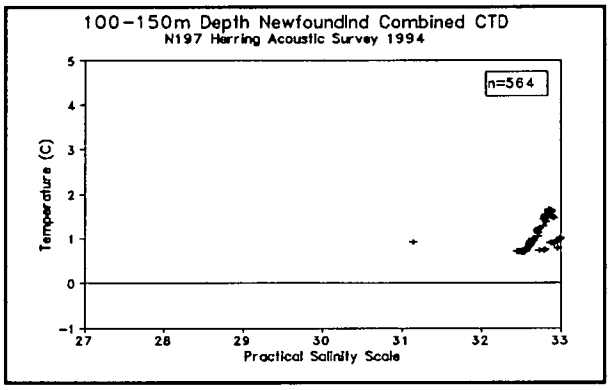


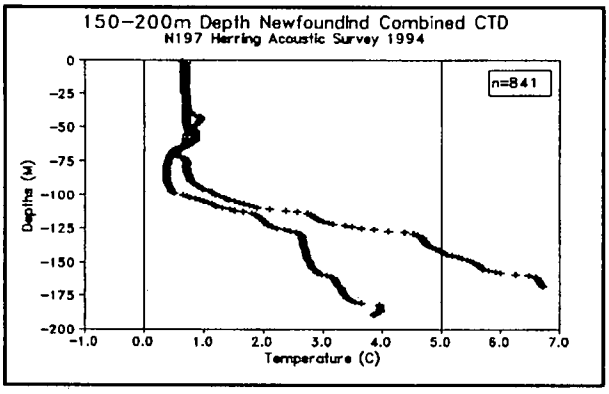
Figure 12a. N197 January 1994 herring acoustic survey combined depth, temperature and salinity data for Cape Breton, presented by various bottom depth ranges (App. 2).











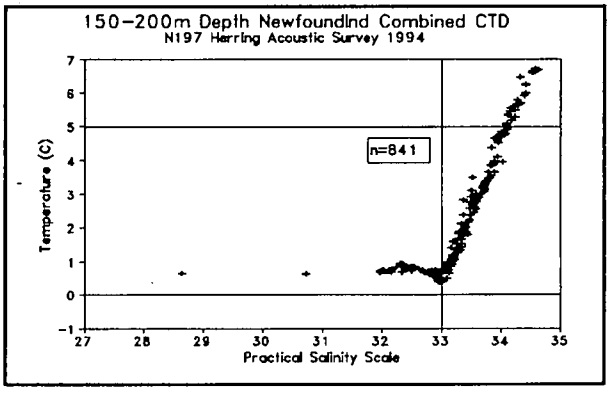


Figure 12b. N197 January 1994 herring acoustic survey combined depth, temperature and salinity data for southwest Newfoundland, presented by various bottom depth ranges (App. 2).

Appendix 1. Formulas used in calculating values given in Tables 1-4. Unless otherwise indicated, lengths are in m, areas are in m^2, time is in hours, area scattering coefficient is in sr^{-1}, total backscattering is in m^2 sr^{-1}, and mass is in tonnes.

Table 2 - formulas for individual transects.

Target strength in dB kg^{-1} = (20 log length - 71.9) - 10 log weight

Notes: This equation is from Foote (1987). Length is mean length of fish in cm. Weight is mean weight in kg at this length.

Total backscattering = transect area x area scattering coefficient

$$\text{Biomass density in kg } m^{-2} = \frac{\text{Area scattering coefficient}}{10^{\left(\frac{\text{target strength}}{10}\right)}}$$

$$\text{Total biomass in tonnes transect}^{-1} = \frac{0.001 \times \text{total backscattering}}{10^{\left(\frac{\text{target strength}}{10}\right)}}$$

Table 3 - formulas for strata

$$\text{Weighting factor} = \frac{\text{transect area}}{\text{mean transect area}}$$

$$\text{Stratum area scattering coefficient} = \frac{1}{\text{number of transects}} \times \sum \left(\text{weighting factor} \times \text{area scattering coefficient for each transect} \right)$$

Mean total backscattering per stratum = stratum area scattering coefficient x stratum area

$$\text{Variance of area scattering coefficient} = \frac{\sum \left(\text{weighting factor}^2 \times \left(\text{area scattering coefficient} - \text{mean of weighted area scattering coefficient} \right)^2 \right)}{\text{number of transects} \times (\text{number of transects} - 1)}$$

$$\text{Variance of total backscattering} = \left(\text{stratum area} \right)^2 \times \text{variance of area scattering coefficient}$$

$$\text{Standard error of total backscattering} = \sqrt{\text{variance of total backscattering}}$$

$$\text{Stratum biomass density in kg m}^{-2} = \frac{\text{stratum area scattering coefficient}}{10^{\left(\frac{\text{target strength}}{10}\right)}}$$

$$\text{Total stratum biomass} = 0.001 \times \text{stratum area} \times \text{stratum biomass density}$$

$$\text{Variance of biomass density} = \frac{\sum \text{weighting factor}^2 \times \left(\text{biomass density} - \text{mean of weighted biomass density}\right)^2}{\text{number of transects} \times (\text{number of transects} - 1)}$$

$$\text{Standard error of total stratum biomass} = \sqrt{0.001^2 \times \text{stratum area}^2 \times \text{variance of biomass density}}$$

Table 4 - Formulas for survey areas

$$\text{Mean total backscattering per survey area} = \sum \text{total backscattering for strata in survey area}$$

$$\text{Variance total backscattering per survey area} = \sum \text{stratum area}^2 \times \text{variance of stratum area scattering coefficient}$$

$$\text{Coefficient of variation of total backscattering per survey area} = \frac{\sqrt{\text{variance total backscattering per survey area}}}{\text{mean total backscattering per survey area}}$$

$$\text{Total biomass per survey area} = \Sigma \text{ biomass for strata in survey area}$$

$$\text{Variance of biomass per survey area} = 0.001^2 \times \sum \text{stratum area}^2 \times \text{variance biomass density within strata}$$

$$\text{Coefficient of variation of biomass per survey area} = \frac{\sqrt{\text{variance of biomass per survey area}}}{\text{mean biomass per survey area}}$$

Appendix 2. January 1994 herring acoustic survey CTD casts bottom depth ranges

Bottom Depth Range (meters)	Cast Number	
	Cape Breton, N.S.	South West Nfld.
0 - 25	1,4	13
25 - 50	6,7,8,10	.
50 - 100	2,9,11	.
100 - 150	3,5	12,15
150 - 200	.	14,16

See Figures 11a and b.