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DISTRIBUTION AND ACOUSTIC BACKSCATTER OF HERRING IN NAFO DIVISION 4T, OCTOBER 1994

by

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ABSTRACT

Due to unforeseen vessel problems, the 1994 acoustic survey was limited to Chaleur Bay and adjacent areas and unable to cover the Cape Breton area. The main herring concentrations, representing 73% of the total survey backscatter recorded, were detected in the Shigawake, Maisonnette, Belledune and Nepisiguit strata. The remaining 27% was also located inside Chaleur Bay. 95% of the biomass detected was in the Chaleur inshore area. No backscatter was detected in the Gaspe and East Miscou strata. The 1994 total biomass estimate of 179,423 tons is higher than the 1993 and 1991 estimates, and close to the 1992 value. The 1994 Chaleur inshore area had the highest proportion of transects with backscatter since 1990, but the lowest percentage of transect length with backscatter detected. Fall spawners represented 68% of the total backscatter detected in 1994, the dominant year-class being 1990, as 4 year-olds. This 1990 year class represents close to 50% of fall spawners in 1994. For the spring spawners, the strongest year-class was 1991 which accounted for 42% of the 1994 spring spawners as 3 year-olds. Water temperatures in all areas and depth ranges varied between 0.1 and 9.5 °C, while the salinity ranged from 27.0 to 32.5.

RESUME

Le relevé acoustique de 1994 n'a recensé qu'une partie du territoire; c'est-à-dire la région de la baie des Chaleurs, sans pouvoir se rendre au Cap Breton. La distribution géographique et la diffusion acoustique des bancs de harengs détectés durant le relevé 1994 indiquent que les strates de Shigawake, Maisonnette, Belledune et Nepisiquit étaient les principales régions de concentration du hareng en octobre, responsables pour 73% du total de la diffusion acoustique. La totalité des autres diffusions acoustiques de hareng furent aussi détectées dans la baie des Chaleurs; 95% de cette diffusion était concentrée dans les strates côtières de la baie. L'estimation de la biomasse d'après l'intensité de la diffusion acoustique est de 179,423 tonnes, valeur supérieure à celles de 1993 et 1991, et comparable à celle de 1992. Pour les strates côtières de la baie des Chaleurs, le pourcentage de lignes avec de la diffusion acoustique présente était à son plus haut niveau depuis quatre ans, tandis que le pourcentage de distance totale couverte sur laquelle il y avait de la diffusion acoustique présente était bas. Les géniteurs d'automne représentaient 68% de la diffusion acoustique de la baie des Chaleurs; la classe d'âge dominante étant celle de 1990 à l'âge de 4 ans. La majorité (42%) des géniteurs de printemps étaient de la classe d'âge de 1991, âgés de 3 ans. La température des masses d'eau variait entre 0.1 et 9.5°C en 1994, avec des salinités variant de 27.0 à 32.5.

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, LeBlanc and Dale 1994). Up until 1990, the surveys were held in the month of November. Since 1991, they have been held in October.

Survey efforts are usually concentrated in the Chaleur Bay and vicinity, as well as the Cape Breton area, where NAFO division 4T herring congregate in the fall. However, due to unforeseen vessel problems, the 1994 survey was limited to the Chaleur Bay and adjacent areas and unable to cover the Cape Breton portion. Consequently, this paper describes the October 1994 distribution and acoustic backscatter of herring in Chaleur Bay and adjacent areas of NAFO Division 4T.

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 400 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 strata, being much larger than all others, were allotted a fixed time for coverage depending on the number of sea days available. Effort was greatest in inshore strata, where most herring schools are found.

The Nepisiguit and Belledune strata were added in 1994 after having detected some acoustic signals while passing in the area in 1993. They are included in the Chaleur backscatter data. 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 16 to 28th with the research vessel Frederick G. Creed. For the first time in recent years, acoustic recordings were done entirely at night, from 20:00 to 06:00 hrs. Transects were run 10 hours a night at an average speed of 12 knots. Available survey time per stratum was allocated so that the density of coverage was directly proportional to the mean backscatter density recorded from the 1985 to 1993 surveys. A second vessel, the J.L. Hart, was used for fishing. The coverage started with western Chaleur Bay, followed by eastern Chaleur Bay and the Gaspe inshore area. Because the vessel F. G. Creed was unable to continue the survey after October 23, the East Miscou strata were covered using the J. L. Hart with the transducer installed in a towed body.

Biological Sampling

Fishing for species identification and biological samples was done at night using an IYGPT midwater trawl. A set was made whenever concentrations of acoustic targets were detected in a particular stratum. CTD profiles for water temperature and salinity gradients were taken with a Seabird SBE 9 Seacat Profiler, at least once per stratum.

The total catch of herring and other species was recorded, and a sample of up to 350 herring was measured. Also, a subsample of 2 herring per 0.5 cm group was frozen for subsequent detailed laboratory analysis. Catch-at-age was determined using age-length keys.

A comparison using SAS GLM procedures was done between catch-at-age proportions and biomass from acoustic surveys, and the fall spawner ADAPT population numbers plus the spring index gillnetter CPUE at age, both obtained from the 1994 4T herring assessment (Claytor et al. 1995).

ACOUSTIC DATA ANALYSIS

Equipment and Calibration

The acoustic equipment consisted of a Simrad 120-25-E single beam transducer with a 10° beamwidth and a Simrad EY200 echo sounder. The signal received by the echosounder was digitised using a Femto model J9001 dual channel digitizer. The transducer was mounted on a torpedo like body which was suspended and fixed

between the two hulls of the Frederick G. Creed. This greatly improved transducer stability and signal, especially in inclement weather conditions. For the Miscou strata, the J.L. Hart was used, and the transducer was mounted on a V-shaped towed body over the side.

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 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

Data Editing and Processing

All data acquisition, editing and processing were done using the Femto Model J9001 Hydroacoustic Data Processing System (HDPS). Species identity of acoustic targets was verified by fishing whenever possible. Most of the major acoustic concentrations were identified in this manner. Targets which could not be verified by fishing were classified using previous surveys criteria on shape and location of positively identified herring targets. Calculations of the mean and the variance of acoustic backscatter and biomass estimates follow procedures outlined by O'Boyle and Atkinson (1989) and Femto HDPS formats (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.

RESULTS

Distribution of Herring and Backscatter Recorded

The distribution of herring encountered during the October 1994 survey is mapped in Figure 2. Most of the herring was located in inshore waters parallel to shore on both the northern and southern coast of Chaleur Bay. The total acoustic scattering intensity of herring detected in each stratum is indicated by relative magnitudes in Figure 3. The intensity of signals detected was also highest in inshore waters of Chaleur Bay. No backscatter was detected in either the Gaspe or East Miscou strata.

The acoustic backscatter recorded per transect within a stratum, in the Chaleur, Gaspe and East Miscou areas is summarised in Table 1. Each transect summary includes the total transect length, the calculated target strength, the average backscatter for the total length of the transect and the biomass density that this average backscatter represents. Also included are the midwater trawl set numbers beside the respective transects where they were cast. The highest single transect biomass density was recorded in the Maisonnette stratum. The Shigawake stratum had the most numerous number of transects with relatively high biomass densities.

The per strata values of biomass density and total are summarised in Table 2. Shigawake stratum had the highest recorded biomass with a value of 55 metric tons, followed by Nepisiquit stratum with 30 tons, Belledune with 24 tons and Maisonnette with 22 tons. These four strata combined accounted for 73% of the total biomass recorded in the 1994 survey.

Mean Density and Biomass Estimates

A summary of the mean biomass density and total biomass estimates for the Southern Gulf in October for the years 1991 to 1994 is presented in Table 3. The 1994 total biomass estimate of 179,423 tons is higher than the 1993 and 1991 estimates and close to the 1992 value. 95% of the 1994 detected biomass was in the Chaleur inshore area. No backscatter was recorded in the East Miscou strata, which accounted for 76% of the total backscatter in 1993, 47% in 1992 and 52% in 1991. Comparing only the Chaleur Bay, Gaspe and East Miscou area between years, the 1994 estimate was the highest of the four years. Biomass was more evenly distributed throughout the Chaleur inshore area, as reflected by the low coefficient of variation value for 1994. Included in Table 3 are the proportions of transects surveyed during night-time (2000 - 0600 HR) and the proportion of backscatter and biomass which was recorded at night.

Figure 4 gives the relative importance of each area contributing to the total biomass estimate since 1991. The confidence interval around the 1994 total biomass estimate is lesser than previous years. This is due to the detected biomass being evenly distributed in the inshore portion of Chaleur Bay. However, other areas such as East Miscou and Gaspe did not contribute to the 1994 total, while the Cape Breton relative biomass contribution was not measured.

Proportion of Transects with Backscatter

In 1994, 72% of transects in the Chaleur Inshore area had backscatter, comparable to the peak value of 73% observed in 1992 (Table 4). Only 25% of transects in the Chaleur Offshore area had backscatter in 1994, comparable to the 1991 value but well below the 1992 and 1993 values. Overall, 58% of the total transects in Chaleur Bay had backscatter, which is comparable to the high 1992 value of 64%.

Percentage of Transect Length with Backscatter

Table 5 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 1991 to 1994. The 1994 survey had the lowest Chaleur total percentage length of transect with backscatter recorded (6.2%), reflecting the highly condensed distribution of herring within inshore waters of the bay.

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%. In 1992, the total transect length covered during the survey was almost double than 1991. The overall percentage length with backscatter was 14%, with Chaleur having 13.1% and Cape Breton 17%.

Trawl sets and sample composition

Herring lengths, weights and spawning group proportions from the 1990 to 1994 acoustic survey samples are summarised in Appendix 2. The 1994 survey set locations can be found in Figure 2 and are listed in Table 2. The corresponding length frequency distributions of herring samples are shown in Figure 5. Mostly adult herring were found in sets made in Chaleur Bay, with a mean length of 28.4 cm. Juvenile herring were found in the Belledune stratum set, as reflected with a peak at 12 cm and a second adult herring peak at 27-28 cm.; the overall mean length being 25.4 cm. The southern Chaleur Bay strata of Nepisiquit, Maisonnette and West Miscou had a wider length distribution than the northern strata of Shigawake and

Newport. Temperature and salinity profiles for these areas are presented in Appendix 3.

Catch-at-age

Catch-at-age matrices from 1990 to 1994 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 6a for fall spawners and Table 6b for spring spawners.

The fall spawners (Table 6a) represented 68% of the 1994 total backscatter detected, 65% of the 1993 total, 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 1994, the dominant year-class was 1990, as 4 year-olds. As seen in Figure 6a, this 1990 year class represents close to 50% of fall spawners in 1994. It was also seen in 1993 as 3 year-olds, representing approximately 25% of the 1993 fall spawners. The percent number at age of the 1987 year-class had been around 40% from 1991 to 1993 in 4T, diminishing in 1994 to approximately 20%.

For the spring spawners, the strongest year-class was 1991 which accounted for 42% of the 1994 spring spawners, 65% in 1993 and 30% in 1992 (Table 6b Figure 6b). The strong 1988 year-class present in 1992 represents 12% of the spring spawners in 1994.

The biomass at age derived from the acoustic estimates are summarised in Table 7a for fall spawners and Table 7b for spring spawners. The 1994 fall spawner biomass at age for area 4T was dominated by the 1990 year-class as 4 year-olds. In the spring spawner biomass at age, the 1991 year-class was the strongest.

The acoustic proportion of numbers and biomass at age were plotted against the ADAPT population numbers for the fall spawners, and the spring index gillnetter CPUE at age for spring spawners, using SAS GLM procedures. In Table 8a, the fall spawner comparison results show that some correlation was found between acoustic proportion of numbers at age for 4 year-olds and ADAPT numbers for 5 year-olds. For biomass at age, acoustic proportions of numbers for 3 year-olds and 5 year-olds correlated with ADAPT numbers for 3 and 5 year-olds respectively.

In Table 8b, spring spawner acoustic biomass at age for 4 year-olds correlated with index gillnetter CPUE numbers for 5 year-olds. The scatter and residual plots of the GLM procedures for both spring and fall spawner acoustic survey data comparisons found to be significant are shown in Appendix 4. With the low number of observation points in our time series (1990-1994), the standardised

residual plots all contain one or more outliers which could cause a misleading fit. As our time series increases with future surveys, we will be able to verify if the regression parameters change and the influence of the outliers on the fitted line.

DISCUSSION

In the 1994 acoustic survey (Oct. 16 to Oct. 28) the main herring concentrations, representing 73% of the total survey backscatter recorded, were detected in the Shigawake, Maisonnette, Belledune and Nepisiguit strata; while the remaining 27% were also located inside Chaleur Bay.

No backscatter was detected in the Gaspe and East Miscou strata, the latter being traditionally the highest area of backscatter detection in recent years (LeBlanc et al. 1993). The absence of backscatter in the East Miscou strata could be due to a timing factor. The East Miscou strata are usually covered at the beginning of the survey. This year, because of a change in vessel and logistics problems, the East Miscou strata were done after the Chaleur Bay and Gaspé area strata. No backscatter was recorded in the northern East Miscou strata when they were surveyed, but while the southern part of East Miscou was being surveyed the following nights, several seiners were present in the northern area and fishing activity was taking place.

The biomass estimate for October 1994 was 179,423 tons. As a relative index, it is higher than the 1993 and 1991 values, and close to the 1992 estimate. Unfortunately, parts of the Chaleur Bay, Gaspe Offshore, as well as all of Cape Breton could not be surveyed during the 1994 acoustic survey. The absolute biomass value is lower than the 1994 VPA model estimate of 375,000 tons of 5+ biomass for 4T fall spawners using the ADAPT framework, as cited in the 1994 4T herring assessment (Claytor et al., 1995). However, the acoustic survey's catch composition was mainly of spring 3 and fall 4 year-olds, which is not directly comparable to the VPA estimate.

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Table 1. Chaleur Bay transect backscatter and biomass density, October 1994 acoustic survey.
Tableau 1. Difusion acoustique et densité de biomasse, baie des Chaleurs, relevé acoustique d'octobre.

Stratum	Transect Number	Transect Length (km)	Target Strength (dB/kg)	Average Sa (dB/m^2)	Biomass Density (Kg/m^2)	Set Number
New_Richmond_Off	2	3.39	-35.25	-55.365	0.0097	
	3	5.40	-35.25	-60.836	0.0028	
	22	11.78	-35.25	-55.165	0.0102	
	23	12.10	-35.25	-54.631	0.0115	
New_Richmond	4	4.75	-35.25	-54.759	0.0112	
	5	5.41	-35.25	-58.122	0.0052	
	6	7.41	-35.25	-58.805	0.0044	
	7	9.82	-35.25	-59.622	0.0037	
	8	9.53	-35.25	-56.259	0.0079	
	9	6.57	-35.25	-51.330	0.0247	
	10	5.55	-35.25	-52.407	0.0192	
	11	5.63	-35.25	-52.944	0.0170	
	24	5.53	-35.25	-53.887	0.0137	
	25	5.77	-35.25	-53.129	0.0163	
	26	6.09	-35.25	-52.295	0.0197	
	27	6.50	-35.25	-52.245	0.0200	
	29	5.98	-35.25	-50.841	0.0276	
Belledune	13	7.09	-34.56	-50.292	0.0267	
	14	5.59	-34.56	-46.757	0.0603	1
	16	5.75	-34.56	-49.652	0.0310	
	17	6.15	-34.56	-47.638	0.0492	
	18	4.67	-34.56	-43.137	0.1388	
	19	5.94	-34.56	-41.276	0.2130	2
	20	7.52	-34.56	-45.785	0.0754	
	44	10.71	-34.56	-52.020	0.0179	
New_Carlilse_Off	21	11.86	-35.25	-60.446	0.0030	
	43	15.26	-35.25	-58.155	0.0051	
	57	17.53	-35.25	-49.879	0.0344	
	58	17.48	-35.25	-49.552	0.0371	
New_Carlilse	30	6.81	-35.25	-51.763	0.0223	
	31	6.75	-35.25	-51.121	0.0259	
	32	6.61	-35.25	-51.573	0.0233	
	33	6.42	-35.25	-50.657	0.0288	
	35	7.23	-35.25	-44.123	0.1296	
	36	5.28	-35.25	-40.935	0.2701	3
	37	5.38	-35.25	-41.684	0.2273	
	39	5.49	-35.25	-42.355	0.1948	
	40	5.57	-35.25	-48.807	0.0441	
	41	6.46	-35.25	-49.162	0.0406	
	42	6.52	-35.25	-52.144	0.0204	
Nepisiguit	45	7.18	-35.25	-57.406	0.0061	
	46	11.09	-35.25	-46.785	0.0702	4
	47	10.48	-35.25	-45.275	0.0994	
	48	9.56	-35.25	-44.430	0.1208	
	49	7.99	-35.25	-42.675	0.1809	
	50	7.24	-35.25	-42.604	0.1839	
	51	6.75	-35.25	-50.764	0.0281	
	52	6.03	-35.25	-42.111	0.2060	
Maisonnette	53	5.19	-35.25	-53.269	0.0158	
	54	5.06	-35.25	-49.053	0.0417	5
	60	4.47	-35.25	-42.393	0.1931	6
	61	4.59	-35.25	-48.204	0.0507	
	62	5.27	-35.25	-43.183	0.1610	7
	63	5.64	-35.25	-51.310	0.0248	
	66	5.52	-35.25	-39.633	0.3645	
	67	5.98	-35.25	-47.143	0.0647	
	68	6.01	-35.25	-47.812	0.0554	
	69	6.40	-35.25	-47.439	0.0604	
	70	6.59	-35.25	-36.329	0.7799	8
	71	8.88	-35.25	-47.717	0.0567	
Central_Chaleur	55	11.26	-35.25	*******	0	
	59	9.80	-35.25	*******	0	
	64	9.38	-35.25	-59.489	0.0038	
	65	10.20	-35.25	-46.059	0.0830	

Tab. 1. (con't) (suite)

Stratum	Transect Number	Transect Length (km)	Target Strength (dB/kg)	Average Sa (dB/m^2)	Biomass Density (Kg/m^2)	Set Number
Shigawake	72	6.66	-35.25	-43.025	0.1669	
	73	5.88	-35.25	-41.711	0.2259	
	74	5.99	-35.25	-45.049	0.1047	
	75	7.16	-35.25	-44.703	0.1134	
	76	6.24	-35.25	-43.102	0.1640	
	101	4.48	-35.25	*******	0	
	102	7.64	-35.25	-48.578	0.0737	
	103	7.72	-35.25	-47.544	0.0590	11
	105	8.93	-35.25	-43.285	0.1580	
	108	9.79	-35.25	-40.395	0.3059	
	107	7.37	-35.25	-40.128	0.3254	12
	109	7.68	-35.25	-44.280	0.1256	
	110	7.51	-35.25	-43.344	0.1551	
	111	7.15	-35.25	-40.232	0.3176	
E-Cent_Chaleur	112	10.52	-35.25	*******	0	
	113	10.83	-35.25	*******	0	
	115	10.31	-35.25	*******	0	
	116	9.83	-35.25	*******	0	
West_Miscou	77	8.29	-35.25	-52.978	0.0169	9
	78	13.11	-35.25	-49.075	0.0415	
	79	13.58	-35.25	-54.15	0.0129	
	80	14.39	-35.25	-62.827	0.0017	
	81	15.36	-35.25	-58.878	0.0043	
	82	12.86	-35.25	*******	0	
	83	13.99	-35.25	-56.313	0.0078	
	84	16.72	-35.25	*******	0	
	85	13.67	-35.25	*******	0	
	86	13.54	-35.25	*******	0	
	87	12.57	-35.25	-61.622	0.0023	
North_Miscou	88	8.81	-35.25	*******	0	
Newport	90	8.15	-35.25	-43.036	0.1665	10
	91	9.24	-35.25	-43.326	0.1557	
	92	9.62	-35.25	-50.686	0.0286	
	93	9.71	-35.25	-47.049	0.0661	
	94	8.71	-35.25	-52.645	0.0182	
	95	8.54	-35.25	*******	0	
	96	8.81	-35.25	-58.001	0.0084	
	97	9.12	-35.25	-50.763	0.0281	
	98	7.13	-35.25	*******	0	
	99	6.60	-35.25	-51.796	0.0221	
Grande_Riviere	119	6.33	-35.25	-55.534	0.0094	
	120	7.72	-35.25	-57.915	0.0054	
	121	7.14	-35.25	-50.463	0.0301	
	122	8.28	-35.25	*******	0	
	123	9.68	-35.25	*******	0	
	124	7.69	-35.25	*******	0	
	125	8.09	-35.25	*******	0	
	126	8.46	-35.25	*******	0	
Anse_Beaufils	127	7.54	-35.25	*******	0	
	128	10.49	-35.25	*******	0	
	129	11.68	-35.25	*******	0	
	130	11.30	-35.25	*******	0	
	131	11.33	-35.25	*******	0	
La_Malbaie	132	10.10	-35.25	*******	0	
	133	15.59	-35.25	*******	0	
	134	16.60	-35.25	*******	0	
	135	15.03	-35.25	*******	0	
Gaspe_Offshore	138	10.28	-35.25	*******	0	
	137	13.09	-35.25	*******	0	
Gaspe	138	8.19	-35.25	*******	0	
	139	7.58	-35.25	*******	0	
	141	7.97	-35.25	*******	0	
East_Miscou_NW	148	0.68	-35.25	*******	0	
	149	12.88	-35.25	*******	0	
	150	12.57	-35.25	*******	0	
	156	7.44	-35.25	*******	0	
	157	4.57	-35.25	*******	0	
	158	12.52	-35.25	*******	0	
	160	12.87	-35.25	*******	0	
	161	12.45	-35.25	*******	0	
East_Miscou_NE	151	13.11	-35.25	*******	0	
	152	13.72	-35.25	*******	0	
	153	11.87	-35.25	*******	0	
	154	13.29	-35.25	*******	0	
	159	13.08	-35.25	*******	0	
	167	13.27	-35.25	*******	0	
East_Miscou_SW	162	12.91	-35.25	*******	0	
	163	12.25	-35.25	*******	0	
	164	11.46	-35.25	*******	0	
	165	12.40	-35.25	*******	0	
	166	12.71	-35.25	*******	0	
East_Miscou_SE	168	12.95	-35.25	*******	0	
	169	12.48	-35.25	*******	0	
	170	12.57	-35.25	*******	0	
	171	12.49	-35.25	*******	0	

Table 2. 1994 October acoustic survey biomass densities and estimates by stratum and area.
Tableau 2. Densités et estimés de biomasse par strate et région, relevé acoustique d'octobre 1994.

Area and Stratum Number	Stratum Name	Average TS (dB/Kg)	Stratum Area (Km^2)	Weighted Mean Sa (dB/m^2)	Biomass Density (Kg/m^2)	Biomass per Stratum (metric tons) Total	SE (tons)	SE % of Total	Set Number
CHALEUR INSHORE									
2	Gaspe_Offshore	-35.3	150.0	0	0	0	0	0	
3	Gaspe	-35.3	117.6	0	0	0	0	0	
4	La_Malbaie	-35.3	191.2	0	0	0	0	0	
5	Anse_Beaufils	-35.3	191.9	0	0	0	0	0	
6	Grande_Riviere	-35.3	173.8	-58.133	0.0051	895	645	72	
7	Newport	-35.3	187.0	-48.193	0.0508	9497	3659	39	10
8	Shigawake	-35.3	323.3	-42.923	0.1709	55252	8552	15	11,12
9	New_Carlilse	-35.3	167.0	-45.854	0.0870	14533	4776	33	3
10	New_Richmond	-35.3	253.6	-53.821	0.0139	3524	547	16	
11	Maisonnette	-35.3	137.5	-43.208	0.1600	22003	8735	40	5,6,7,8
12	West_Miscou	-35.3	354.0	-56.587	0.0074	2602	1334	51	9
+23a	East_Miscou_NW	-35.3	524.0	0	0	0	0	0	
+23d	East_Miscou_SW	-35.3	524.0	0	0	0	0	0	
*@49	Belledune	-34.6	348.0	-46.178	0.0689	23978	8254	34	1,2
@50	Nepisiguit	-35.3	278.0	-44.876	0.1090	30301	7336	24	4
CHALEUR OFFSHORE									
18	E_Cent_Chaleur	-35.3	239.4	0	0	0	0	0	
19	Central_Chaleur	-35.3	208.0	-51.886	0.0217	4513	4255	94	
20	New_Carlilse_Off	-35.3	410.4	-51.826	0.0220	9029	3768	42	
21	New_Richmond_Off	-35.3	350.1	-55.512	0.0094	3296	689	21	
22	North_Miscou	-35.3	417.8	0	0	0	0	0	
+23c	East_Miscou_SE	-35.3	524.0	0	0	0	0	0	
+23b	East_Miscou_NE	-35.3	524.0	0	0	0	0	0	

@ Additional strata since 1993
+ East Miscou stratum subdivided
* Sets included both juvenile and adult herring

Table 3. Total biomass density and estimates in the Southern Gulf of St. Lawrence, October 1991-1994.
Tableau 3. Densités et estimés totales de biomasse dans le sud du golfe St.-Laurent, octobre 1991-1994.

Year	Area	Number of Transects	Proportion * covered at night	Mean Density (Kg/m^2)	Estimated Biomass (t/area)	C.V.	Proportion * recorded at night
@ 1994	CHALEUR INSHORE +	106	1.0	0.0415	162585	0.11	1.0
	CHALEUR OFFSHORE ++	27	1.0	0.0063	16838	0.34	1.0
	CAPE BRETON INSHORE	--	--	--	--	--	--
	CAPE BRETON OFFSHORE	--	--	--	--	--	--
	1994 TOTAL ** ***	133	1.0	0.0272	179423	0.10	1.0
1993	CHALEUR INSHORE +	163	0.71	0.0202	114052	0.35	0.93
	CHALEUR OFFSHORE ++	45	0.02	0.001	4284	0.41	0
	CAPE BRETON INSHORE	91	0.84	0.0039	7945	0.23	0.68
	CAPE BRETON OFFSHORE	39	0.18	0.0019	4567	0.41	0.09
					0		
	1993 TOTAL ** ***	338	0.58	--	130848	0.31	0.85
1992	CHALEUR INSHORE	216	0.57	0.0207	48258	0.10	0.65
	CHALEUR OFFSHORE +++	102	0.48	0.0078	96582	0.52	0.75
	CAPE BRETON INSHORE	78	0.58	0.0227	44762	0.25	0.85
	CAPE BRETON OFFSHORE	22	0.14	0.0008	83	0.69	0
	1992 TOTAL **	418	0.53	--	189685	0.29	0.75
1991	CHALEUR INSHORE	158	0.59	0.0054	16724	0.46	0.87
	CHALEUR OFFSHORE +++	50	0.32	0.0015	23214	0.55	0.65
	CAPE BRETON INSHORE	49	0.61	0.0026	4418	0.32	0.98
	CAPE BRETON OFFSHORE	0	0	0	0	0.00	0
	1991 TOTAL	257	0.54		44356	0.33	0.75

@ Partial survey, Cape Breton area not covered.
* 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 4. Total number of transects per stratum and proportion of transects with herring backscatter for the years 1991 to 1994.
Tableau 4. Nombre total de lignes par strate et proportion de lignes avec diffusion acoustique attribuée au hareng, 1991-1994.

Strata number	Strata	1994 OCTOBER Number of transects	1994 OCTOBER Proportion with herring	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
CHALEUR	**INSHORE**								
1	CAP.BON.AMI	–	–	14	0.00	6	0.50	4	0.25
2	GASPE.OFFSHORE	2	0.00	12	0.00	10	0.20	4	0.00
3	GASPE	3	0.00	10	0.10	8	0.63	10	0.50
4	MALBAIE	4	0.00	12	0.33	4	0.75	4	0.50
5	ANSE.BEAUFILS	5	0.00	12	0.00	8	0.25	6	0.17
6	GRANDE.RIVIERE	8	0.38	19	0.42	13	1.00	18	0.00
7	NEWPORT	10	0.80	14	0.29	29	0.62	20	0.50
8	SHIGAWAKE	14	0.93	19	0.00	37	1.00	34	0.79
9	NEW.CARLISLE	11	1.00	–	–	9	1.00	10	0.80
10	NEW.RICHMOND	13	1.00	–	–	23	0.61	10	0.20
11	MAISONNETTE	12	1.00	–	–	33	1.00	7	1.00
12	WEST.MISCOU	11	0.64	14	1.00	36	0.53	31	0.65
	INSHORE PROPORTION	**93**	**0.72**	**126**	**0.25**	**216**	**0.73**	**158**	**0.53**
CHALEUR	**OFFSHORE**								
14	AMERICAN.BANK	–	–	2.00	–	11	0.91	4	0.25
17	NEWPORT.OFFSHORE	–	–	6	0.00	9	0.11	4	0.50
18	EAST.CENTRAL.CHALEUR	4	0.00	5	0.00	14	0.00	9	0.00
19	CENTRAL.CHALEUR	4	0.50	4	0.00	15	0.00	7	0.00
20	CARLISLE.OFFSHORE	4	1.00	–	–	7	1.00	4	0.25
21	RICHMOND.OFFSHORE	4	1.00	–	–	7	0.57	10	0.20
22	NORTH.MISCOU	1	0.00	–	–	9	0.56	12	0.08
23	EAST.MISCOU	23	0.00	32	0.81	6	0.67	6	1.00
	(23a - southwest)	(5)	0.00	(8)	(1.00)				
	(23b - northwest)	(8)	0.00	(8)	(1.00)				
	(23c - northeast)	(6)	0.00	(8)	(.38)				
	(23d - southeast)	(4)	0.00	(8)	(.88)				
	OFFSHORE PROPORTION	**40**	**0.25**	**49**	**0.53**	**78**	**0.40**	**56**	**0.23**
	CHALEUR TOTAL	**133**	**0.58**	**175**	**0.33**	**294**	**0.64**	**214**	**0.45**
CAPE BRETON INSHORE									
27	PLEASANT.BAY	–	–	8	0.25	6	0.50	4	0.25
29	ASPY.BAY	–	–	10	0.50	6	1.00	4	0.75
30	NEIL.HARBOUR	–	–	9	0.89	17	0.82	12	0.25
31	WRECK.COVE	–	–	8	1.00	8	0.88	6	1.00
32	ST.ANNS.BAY	–	–	8	0.38	4	0.25	4	0.50
33	HADDOCK.BANK	–	–	7	0.43	4	0.75	3	0.67
34	SYDNEY	–	–	8	0.88	4	1.00	3	1.00
35	NEW.WATERFORD	–	–	10	0.60	10	0.90	6	0.50
36	DONKIN	–	–	7	1.00	9	1.00	4	0.50
	INSHORE PROPORTION	-	-	**75**	**0.65**	**68**	**0.82**	**46**	**0.54**
CAPE BRETON OFFSHORE									
39	LAWRENCE.OFFSHORE	-	-	4	0.25	4	0.25	3	0.33
	OFFSHORE PROPORTION	-	-	4	0.25				
	CAPE BRETON TOTAL	–	–	**79**	**0.63**	**72**	**0.79**	**49**	**0.53**
	CHALEUR/C.BRETON TOTAL	–	–	**254**	**0.42**	**366**	**0.67**	**263**	**0.46**
ADDITIONAL TRANSECTS									
	CHALEUR INSHORE	–	–	21	0.33				
	CHALEUR OFFSHORE	–	–	12	0.50	24	0.33	–	–
	MILNE (EAST PEI)	–	–	10	0.40	8	0.25	–	–
	CAPE BRETON INSHORE	–	–	16	0.19	9	0.78	–	–
	CAPE BRETON OFFSHORE	–	–	35	0.26	18	0.06	4	0.00
	ADDITIONAL TRANS. TOTAL	-	-	**94**	**0.31**	**59**	–	**4**	–

Table 5. Total transect lengths (nm) per stratum, length (Herr. nm) having herring, and percentage thereof, for the years 1991 to 1994.
Tableau 5. Longueur totale (nm) des lignes parcourues , distance avec signaux acoustiques de harengs (Herr. nm) et pourcentage de la longueur totale (1991-1994).

		1994			1993			1992			1991		
		nm	Herr. nm	%	nm	Herr. nm	%	nm	Herr. nm	%	nm	Herr. nm	%
Chaleur Inshore													
1	Cap Bon Ami	.	.	.	61.0	0.0	0.0	25.1	0.8	3.3	17.1	0.0	0.0
2	Gaspe Offshore	12.7	0.0	0.0	66.4	0.0	0.0	50.8	2.1	4.1	20.9	0.0	0.0
3	Gaspe Bay	12.9	0.0	0.0	28.6	0.0	0.0	27.8	3.8	13.5	30.2	3.3	10.9
4	La Malbaie	31.1	0.0	0.0	83.2	0.3	0.2	34.0	1.7	4.9	23.4	4.4	18.8
5	Anse a Beaufils	28.4	0.0	0.0	49.1	0.0	0.0	38.9	2.5	6.4	18.6	1.5	8.1
6	Grande Riviere	33.3	0.0	0.0	67.5	1.6	1.3	55.5	12.1	21.8	60.5	0.0	0.0
7	Newport	46.5	3.6	7.7	57.2	1.6	1.5	128.2	13.0	10.1	67.6	12.9	19.1
8	Shigawake	54.5	13.6	25.0	57.8	0.0	0.0	158.4	46.0	29.0	105.3	31.9	30.3
9	New Carlilse	37.2	7.7	20.7	.	.	.	25.8	3.0	11.6	29.2	9.0	30.8
10	New Richmond	45.9	0.0	0.0	.	.	.	72.3	0.0	0.0	22.2	1.4	6.3
11	Maisonnette	37.8	7.0	18.5	.	.	.	89.5	23.0	25.7	16.1	6.2	38.5
12	West Miscou	80.4	5.4	6.7	71.8	14.8	11.1	17.0	14.5	85.3	25.2	23.8	94.4
	SUB TOTAL	**420.9**	**37.2**	**8.8**	**542.7**	**18.3**	**3.4**	**723.3**	**122.4**	**16.9**	**436.3**	**94.4**	**21.6**
q													
Chaleur Offshore													
14	American Bank	.	.	.	10.0	0.0	0.0	14.1	5.0	35.5	14.1	0.0	0.0
19	Central Chaleur	22.1	0.5	8.0	21.1	0.0	0.0	66.0	0.0	0.0	35.2	7.6	21.6
22	North Miscou	4.8	0.0	0.0	.	.	.	64.3	3.5	5.4	25.2	0.0	0.0
23	East Miscou	144.7	0.0	0.0	219.2	47.0	11.6	95.7	25.8	27.0	84.7	5.6	6.6
	SUB TOTAL	**171.6**	**0.5**	**0.3**	**250.3**	**47.0**	**19.6**	**240.1**	**34.3**	**14.3**	**159.2**	**13.2**	**8.3**
Chaleur Offshore (Partial)													
13	Bon Ami Offshore	.	.	.	.	.	.	47.5	1.3	2.6	.	.	.
15	Bonaventure Offshore	.	.	.	16.7	1.0	3.2	33.5	4.2	12.4	.	.	.
16	Beaufils Offshore	.	.	.	15.1	0.0	0.0	32.6	1.3	3.8	.	.	.
17	Newport Offshore	.	.	.	34.6	0.0	0.0	50.7	0.0	0.0	23.7	2.9	12.2
18	E. Central Chaleur	22.5	0.0	0.0	28.1	0.0	0.0	80.9	0.0	0.0	49.7	13.3	26.8
20	Carlilse Offshore	33.8	2.8	8.2	.	.	.	57.0	3.0	5.3	36.5	0.0	0.0
21	Richmond Offshore	17.8	1.1	6.0	.	.	.	40.4	5.0	12.4	20.1	0.0	0.0
	SUB TOTAL	**74.0**	**3.8**	**5.2**	**94.5**	**1.0**	**1.1**	**342.6**	**14.7**	**4.3**	**130.0**	**16.2**	**12.5**
	CHALEUR TOTAL	**666.5**	**41.5**	**6.2**	**887.4**	**66.3**	**7.6**	**1306.0**	**171.4**	**13.1**	**725.5**	**123.8**	**17.1**
Cape Breton Inshore													
27	Pleasant Bay	.	.	.	31.3	2.9	5.0	21.3	2.9	13.6	18.5	0.0	0.0
28	Bay St. Lawrence	.	.	.	32.4	1.5	2.5	16.7	0.7	4.2	15.4	0.6	3.9
29	Aspy Bay	.	.	.	36.2	4.6	6.9	35.0	17.7	50.6	8.6	4.8	55.8
30	Neil Harbour	.	.	.	42.7	7.4	9.4	28.4	9.7	34.2	8.5	3.2	37.6
31	Wreck Cove	.	.	.	32.9	1.9	3.1	31.8	7.4	23.3	31.2	6.1	19.6
32	St. Ann's Bay	.	.	.	27.0	1.9	3.8	17.8	0.0	0.0	12.8	0.7	5.5
33	Haddock Bank	.	.	.	37.3	1.3	1.9	20.2	7.2	35.6	14.4	1.7	11.8
34	Sydney	.	.	.	43.7	5.3	6.5	18.6	3.8	20.4	17.9	6.7	37.4
35	New Waterford	.	.	.	44.8	1.1	1.3	52.9	5.1	9.6	25.5	4.6	18.0
36	Donkin	.	.	.	29.7	1.9	3.5	41.7	9.1	21.8	25.6	1.5	5.9
	SUB TOTAL	.	.	.	**358.0**	**29.8**	**8.3**	**284.4**	**63.6**	**22.4**	**178.4**	**29.9**	**16.8**
Cape Breton Inshore (Partial)													
26	White Capes	.	.	.	32.4	0.0	0.0	15.3	2.1	13.7	.	.	.
	SUB TOTAL	.	.	.	**32.4**	**0.0**	**0.0**	**15.3**	**2.1**	**13.7**	.	.	.
Cape Breton Offshore													
37	White Cape Offshore	.	.	.	20.5	0.0	0.0	22.3	0.0	0.0	.	.	.
38	Pleasant Offshore	.	.	.	22.1	0.0	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	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	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**
	CAPE BRETON TOTAL	.	.	.	**605.8**	**43.3**	**7.1**	**409.3**	**68.9**	**16.8**	**197.0**	**29.9**	**15.2**
Chaleur and Cape Breton	**GRAND TOTAL**	.	.	.	**1493.3**	**109.6**	**7.4**	**1715.3**	**240.3**	**14.0**	**922.5**	**153.7**	**16.7**

Table 6a. Catch-at-age matrices for herring FALL spawners, by NAFO area, from acoustic surveys, 1990-1994. Values are in percentage of numbers at age weighted by proportion of backscatter.
Tableau 6a. Prises à l'âge de harengs géniteurs d'AUTOMNE, par zone de l'OPANO, dans les relevés acoustiques, 1990-1994.

Fall spawners NAFO 4T	AGE	1990	1991	1992	1993	1994
	0	0.00	0.00	0.00	0.00	0.00
	1	14.40	0.57	0.00	0.00	0.58
	2	49.89	3.31	4.40	1.77	0.43
	3	21.30	27.98	2.89	22.65	1.31
	4	5.60	38.68	20.48	10.97	48.65
	5	0.00	8.71	35.74	9.33	15.33
	6	0.00	2.89	7.19	37.86	14.86
	7	0.00	1.89	2.40	7.49	15.23
	8	0.00	2.84	2.29	0.00	1.93
	9	0.00	1.63	0.86	0.43	1.03
	10	0.00	0.65	1.59	0.00	0.00
	11+	0.00	2.15	1.76	0.00	0.65
NAFO 4T Percentage of total backscatter		91.20	91.30	79.60	90.50	100.00

Fall spawners NAFO 4Vn	AGE	1990	1991	1992	1993	1994
	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	0.00

Fall spawners Total NAFO 4TVn	AGE	1990	1991	1992	1993	1994
	0	0.00	0.00	0.00	0.00	0.00
	1	14.40	0.57	0.00	0.00	0.58
	2	49.89	3.31	4.68	1.89	0.43
	3	21.74	28.16	3.31	23.60	1.31
	4	7.28	40.87	22.60	11.82	48.65
	5	1.26	9.53	38.82	13.29	15.33
	6	1.44	4.00	8.84	39.50	14.86
	7	1.21	2.61	3.53	8.29	15.23
	8	0.60	4.51	4.73	0.29	1.93
	9	0.33	2.25	2.89	0.72	1.03
	10	0.56	0.93	3.23	0.24	0.00
	11+	1.28	3.25	7.38	0.36	0.65

Table 6b. Catch-at-age matrices from SPRING spawning herring, by NAFO area, from acoustic surveys 1990 - 1994. Values are in percentage of number at age weighted by proportion of backscatter.
Tableau 6b. Prises à l'âge de harengs géniteurs de PRINTEMPS, par zone de l'OPANO, dans les relevés acoustiques, 1990-1994.

Spring spawners NAFO 4T	AGE	1990	1991	1992	1993	1994
	0	0.43	0.00	0.00	0.00	8.53
	1	42.04	16.71	23.87	6.04	0.22
	2	45.50	40.42	15.62	60.63	1.17
	3	2.66	19.09	8.74	5.57	42.06
	4	0.18	6.98	21.26	10.13	16.51
	5	0.08	1.91	4.74	8.14	14.08
	6	0.23	0.90	2.40	0.00	12.21
	7	0.00	1.45	0.87	0.00	3.00
	8	0.00	1.03	0.95	0.00	0.17
	9	0.08	1.38	0.53	0.00	1.06
	10	0.00	0.47	0.64	0.00	0.50
	11+	0.00	0.94	0.00	0.00	0.52
NAFO 4T Percentage of total backscatter		91.20	91.29	79.60	90.50	100.00

Spring spawners NAFO 4Vn	AGE	1990	1991	1992	1993	1994
	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	0.00

Spring spawners Total NAFO 4TVn	AGE	1990	1991	1992	1993	1994
	0	0.43	0.00	0.00	0.00	8.53
	1	42.15	16.71	28.65	7.32	0.22
	2	47.09	43.15	20.47	64.99	1.17
	3	2.93	20.98	14.16	6.70	42.06
	4	3.10	6.98	23.40	10.63	16.51
	5	1.24	1.91	4.74	8.14	14.08
	6	0.56	4.98	3.44	2.18	12.21
	7	1.61	1.45	0.87	0.00	3.00
	8	0.00	1.03	0.95	0.00	0.17
	9	0.55	1.38	2.70	0.00	1.06
	10	0.34	0.47	0.64	0.00	0.50
	11+	0.00	0.94	0.00	0.00	0.52

Table 7a. Biomass (t) at age matrices for FALL spawners by NAFO area, derived from acoustic survey estimates, 1990-94.
Tableau 7a. Biomasse à l'âge (tonnes) pour les géniteurs d'AUTOMNE, par zone de l'OPANO, obtenue des estimations de relevés acoustiques, 1990-94.

FALL Spawners NAFO 4T	AGE	1990	1991	1992	1993	1994
	0	0.0	0.0	0.0	0.0	0.0
	1	16280.9	26.4	0.0	0.0	53.9
	2	126195.8	482.1	2088.2	674.3	237.5
	3	86212.7	6399.9	2567.0	1421.1	1230.4
	4	27004.7	11349.2	23612.0	15249.8	52423.6
	5	0.0	2930.0	46536.5	40789.9	18105.7
	6	0.0	1155.0	10826.0	9988.6	20328.2
	7	0.0	850.7	3971.0	4213.4	22715.7
	8	0.0	1435.2	4448.0	0.0	3212.2
	9	0.0	831.2	1548.5	2214.6	1979.7
	10	0.0	362.3	3258.4	0.0	0.0
	11	0.0	1335.8	3980.7	0.0	1720.6
Total Biomass		255694.1	27157.8	102836.4	74551.7	122007.6

FALL Spawners NAFO 4Vn	AGE	1990	1991	1992	1993	1994
	0	0.0	0.0	0.0	0.0	--
	1	0.0	0.0	0.0	0.0	--
	2	0.0	1.2	146.8	56.1	--
	3	3916.1	57.4	426.8	730.3	--
	4	18214.5	820.8	2929.0	814.5	--
	5	14732.3	349.7	4964.5	4494.2	--
	6	20299.6	504.0	3055.3	2057.2	--
	7	18484.4	381.4	2060.3	1186.6	--
	8	9407.8	963.7	5498.3	453.3	--
	9	5777.8	393.5	4741.2	545.8	--
	10	10266.3	174.3	4147.0	457.6	--
	11	23330.3	727.9	15082.2	715.5	--
Total Biomass		124429.1	4373.8	43051.2	11511.0	--

FALL Spawners NAFO4TVn	AGE	1990	1991	1992	1993	1994
	0	0.0	0.0	0.0	0.0	--
	1	16280.9	26.4	0.0	0.0	--
	2	126195.8	483.3	2235.0	730.4	--
	3	90128.8	6457.3	2993.8	2151.3	--
	4	45219.2	12170.0	26540.9	16064.4	--
	5	14732.3	3279.7	51501.0	45284.1	--
	6	20299.6	1659.0	13881.3	12045.8	--
	7	18484.4	1232.1	6031.2	5400.0	--
	8	9407.8	2398.8	9946.3	453.3	--
	9	5777.8	1224.7	6289.8	2760.4	--
	10	10266.3	536.6	7405.4	457.6	--
	11	23330.3	2063.7	19062.9	715.5	--
Fall Biomass		380123.2	31531.7	145887.6	86062.7	122007.6
Fall proportion		0.41	0.71	0.77	0.66	0.68

Table 7b. Biomass (t) at age matrices for SPRING spawners, by NAFO area, from acoustic survey estimates, 1990-94.
Tableau 7b. Biomasse à l'âge (tonnes) pour les géniteurs de PRINTEMPS par zone de l'OPANO, obtenue des estimations de relevés acoustiques 1990-94.

SPRING Spawners NAFO 4T	AGE	1990	1991	1992	1993	1994
	0	674.7	0.0	0.0	0.0	350.8
	1	184063.1	1254.5	5572.3	1635.3	37.0
	2	323725.8	4884.1	5200.0	25778.3	432.6
	3	25128.0	2918.5	5253.1	2799.2	22840.1
	4	2830.9	1341.1	15867.7	6653.5	9777.6
	5	1415.6	415.5	4079.1	6918.1	9285.7
	6	3738.1	244.7	2283.9	0.0	9596.0
	7	0.0	390.8	789.2	0.0	2581.3
	8	0.0	355.1	1457.7	0.0	154.3
	9	1773.7	452.4	641.6	0.0	1151.9
	10	0.0	137.6	859.1	0.0	516.7
	11	0.0	385.7	0.0	0.0	691.3
Total Biomass		543349.9	12780.2	42003.6	43784.3	57415.4

SPRING Spawners NAFO 4Vn	AGE	1990	1991	1992	1993	1994
	0	0.0	0.0	0.0	0.0	--
	1	40.8	0.0	185.3	58.6	--
	2	1103.0	10.0	286.5	373.2	--
	3	208.0	7.7	465.1	96.8	--
	4	3600.5	0.0	302.5	56.5	--
	5	1313.5	0.0	0.0	0.0	--
	6	345.6	26.4	154.8	415.9	--
	7	2646.1	0.0	0.0	0.0	--
	8	0.0	0.0	0.0	0.0	--
	9	886.0	0.0	399.6	0.0	--
	10	676.5	0.0	0.0	0.0	--
	11	0.0	0.0	0.0	0.0	--
Total Biomass		10819.9	44.2	1793.8	1001.0	--

SPRING Spawners NAFO4TVn	AGE	1990	1991	1992	1993	1994
	0	674.7	0.0	0.0	0.0	--
	1	184103.9	1254.5	5757.5	1693.9	--
	2	324828.8	4894.1	5486.5	26151.4	--
	3	25336.0	2926.2	5718.2	2896.0	--
	4	6431.4	1341.1	16170.3	6709.9	--
	5	2729.1	415.5	4079.1	6918.1	--
	6	4083.7	271.1	2438.7	415.9	--
	7	2646.1	390.8	789.2	0.0	--
	8	0.0	355.1	1457.7	0.0	--
	9	2659.7	452.4	1041.1	0.0	--
	10	676.5	137.6	859.1	0.0	--
	11	0.0	385.7	0.0	0.0	--
Spring Biomass		554169.8	12824.3	43797.4	44785.3	57415.4
Spring proportion		0.59	0.29	0.23	0.34	0.32

Table 8a. ACOUSTIC FALL spawners number and biomass (t) at age comparison to ADAPT FALL spawner population estimates , using 4TVn numbers for the years 1990 to 1994.
Tableau 8a. Comparaison entre les nombres et la biomasse (t) à l'âge des relevés acoustiques pour les géniteurs d'AUTOMNE et les estimés de population selon ADAPT, zone 4TVn, années 1990 -1994.

GENERAL LINEAR MODEL PROCEDURES
FALL spawners Proportion at age vs ADAPT population numbers — Significant at Pr > F 0.05
Dependant variable = Acoustic proportion of numbers at age — S=signif NS=non signif

ACOUSTIC AGE	ADAPT AGE	R-Square	Pr > F	RESULT	NUMBER OF OBSERVATIONS
3	3	0.33	0.31	NS	5
3	4	0.18	0.57	NS	4
3	5	0.45	0.53	NS	3
4	4	0.11	0.57	NS	5
4	5	0.93	0.03	S	4 * A
5	5	0.74	0.06	NS	5

FALL spawners Biomass (t) at age vs ADAPT population numbers
Dependant variable = Acoustic biomass (T) at age

ACOUSTIC AGE	ADAPT AGE	R-Square	Pr > F	RESULT	NUMBER OF OBSERVATIONS
3	3	0.84	0.03	S	5 * B
3	4	0.84	0.08	NS	4
4	4	0.07	0.66	NS	5
4	5	0.22	0.53	NS	4
5	5	0.8	0.04	S	5 * C
5	6	0.75	0.13	NS	4

Table 8b. ACOUSTIC SPRING spawners numbers and biomass (t) at age versus SPRING spawner CPUE from index gillnetters, using 4TVn totals for the years 1990 to 1994.
Tableau 8b. Comparaison entre les nombres et la biomasse (t) à l'âge des relevés acoustiques pour les géniteurs de PRINTEMPS et les estimés des pecheurs repères, zone 4TVn, années 1990 -1994.

GENERAL LINEAR MODEL PROCEDURES
SPRING spawners Proportion of numbers at age vs gillnetter CPUE — Significant at Pr > F 0.05
Dependant variable = Acoustic proportion of numbers at age — S=signif NS=non signif

ACOUSTIC AGE	INDEX AGE	R-Square	Pr > F	RESULT	NUMBER OF OBSERVATIONS
3	3	0.04	0.73	NS	5
4	4	0.01	0.84	NS	5
4	5	0.82	0.09	NS	4
5	5	0.02	0.87	NS	4

SPRING spawners Biomass (T) at age vs gillnetter CPUE
Dependant variable = Acoustic biomass (T) at age

ACOUSTIC AGE	INDEX AGE	R-Square	Pr > F	RESULT	NUMBER OF OBSERVATIONS
3	3	0.11	0.58	NS	5
4	4	0.51	0.17	NS	5
4	5	0.93	0.03	S	4 * D
5	5	0.53	0.27	NS	4

* See graphic results in Appendix 4 / Voir resultats dans l'Annexe 4

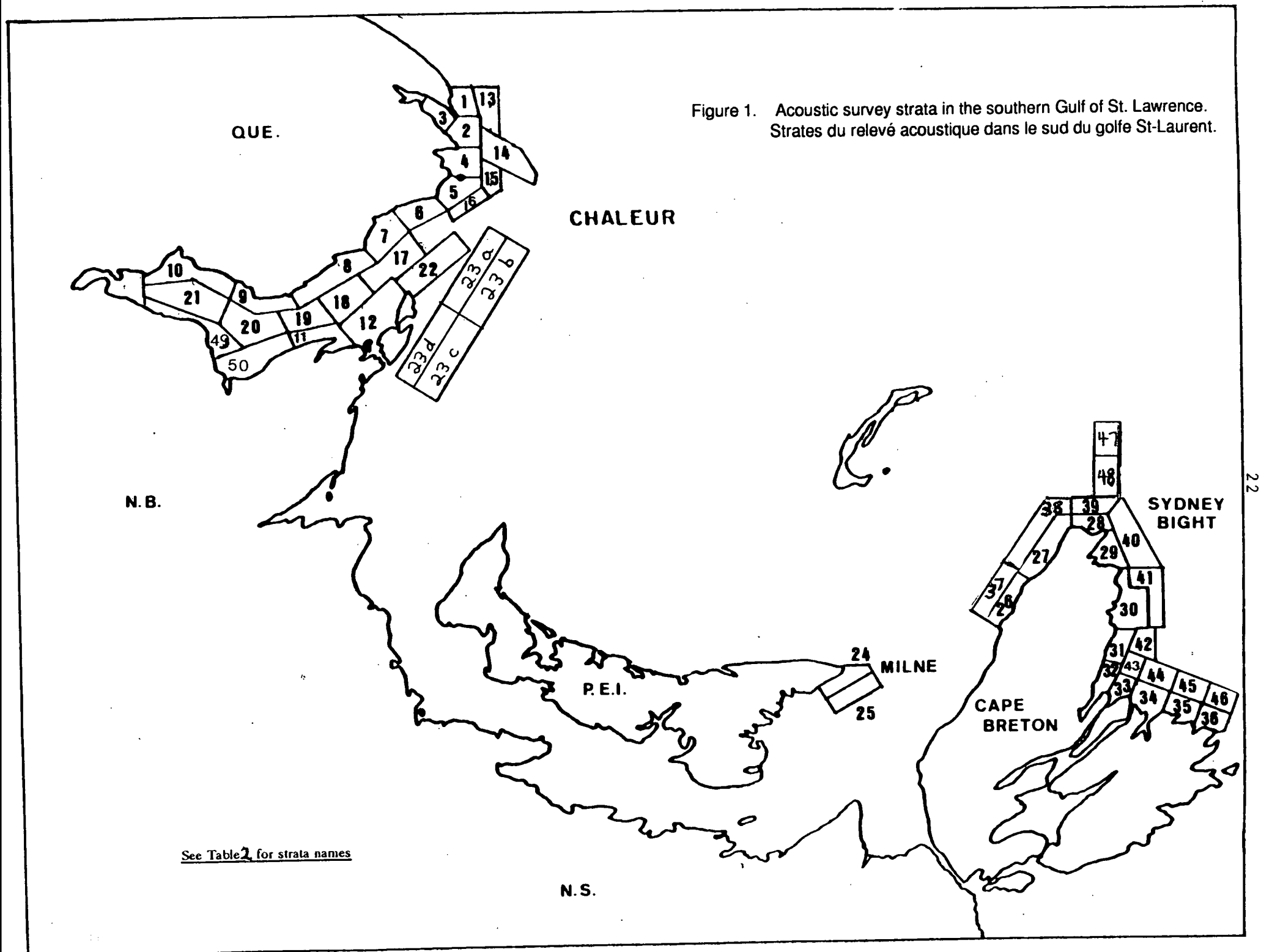
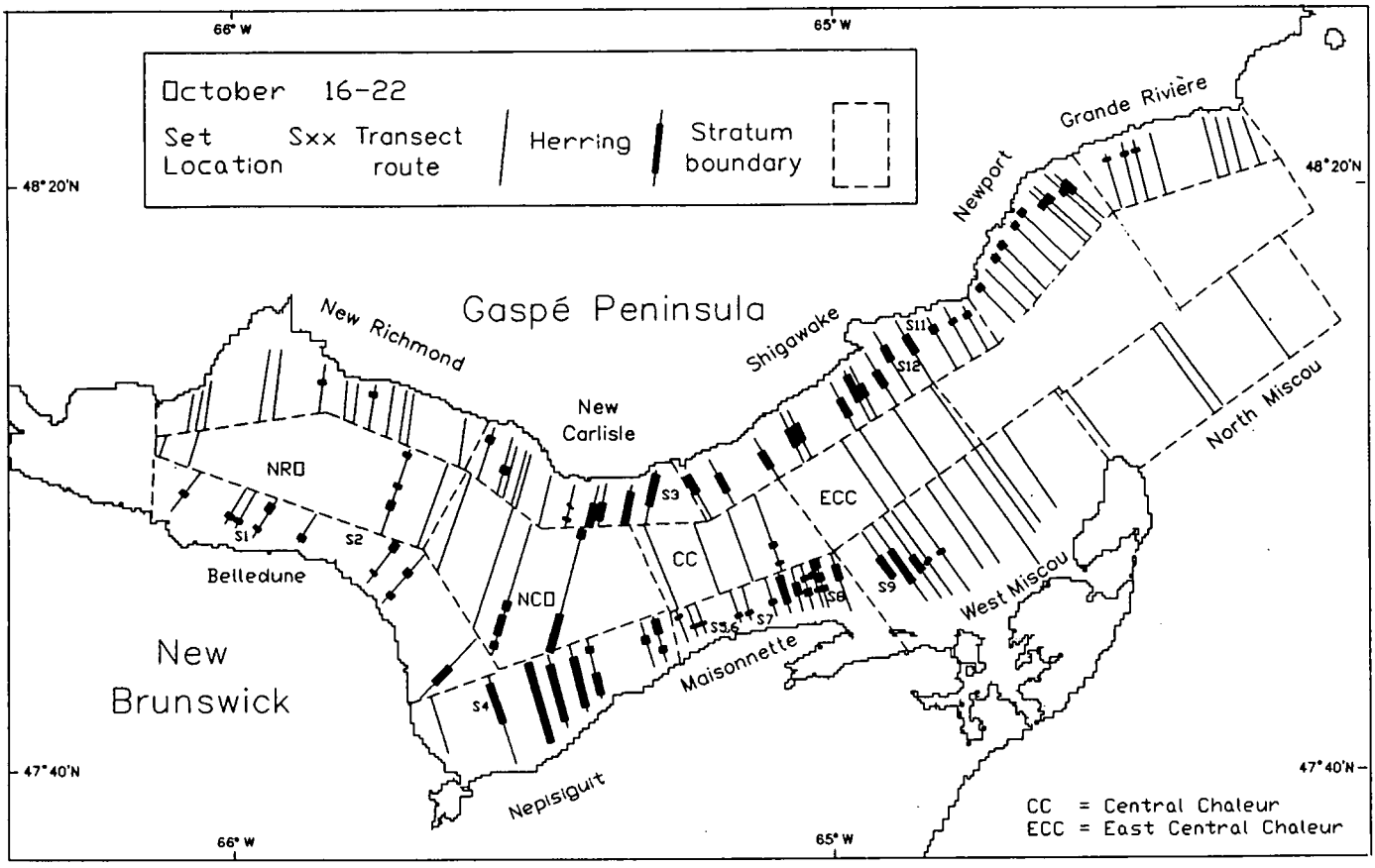
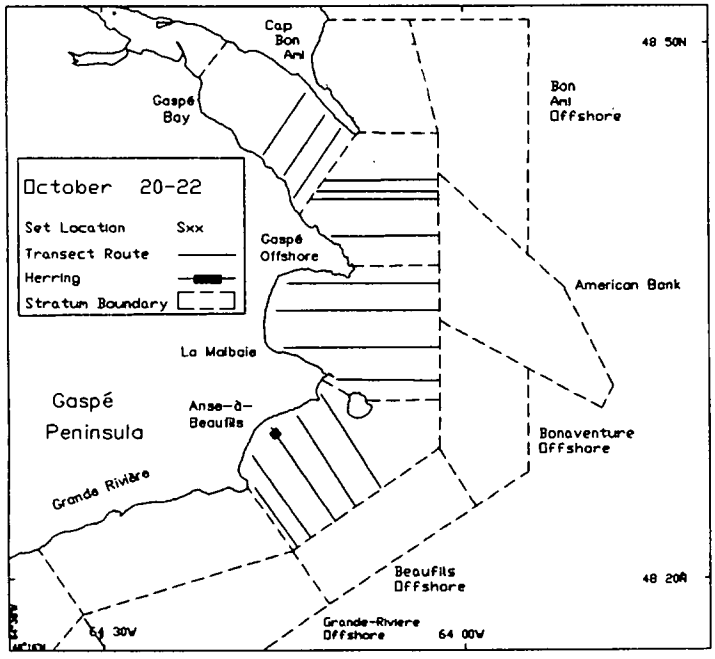


Figure 1. Acoustic survey strata in the southern Gulf of St. Lawrence.
Strates du relevé acoustique dans le sud du golfe St-Laurent.





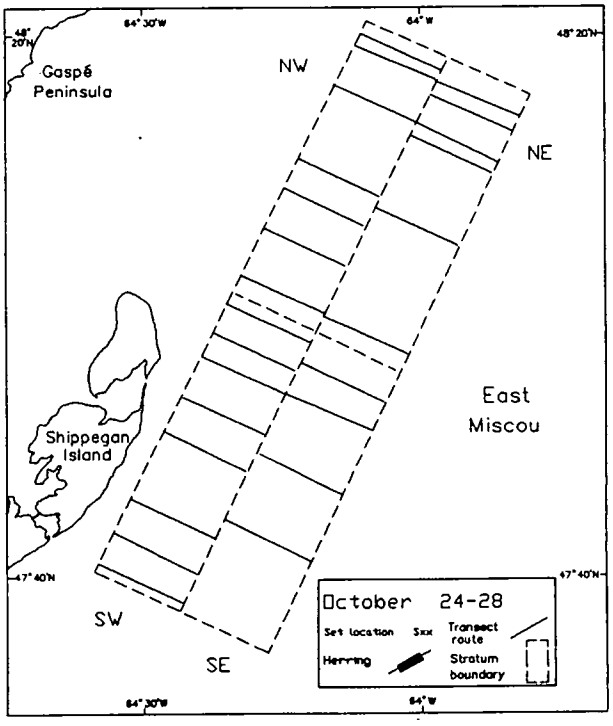
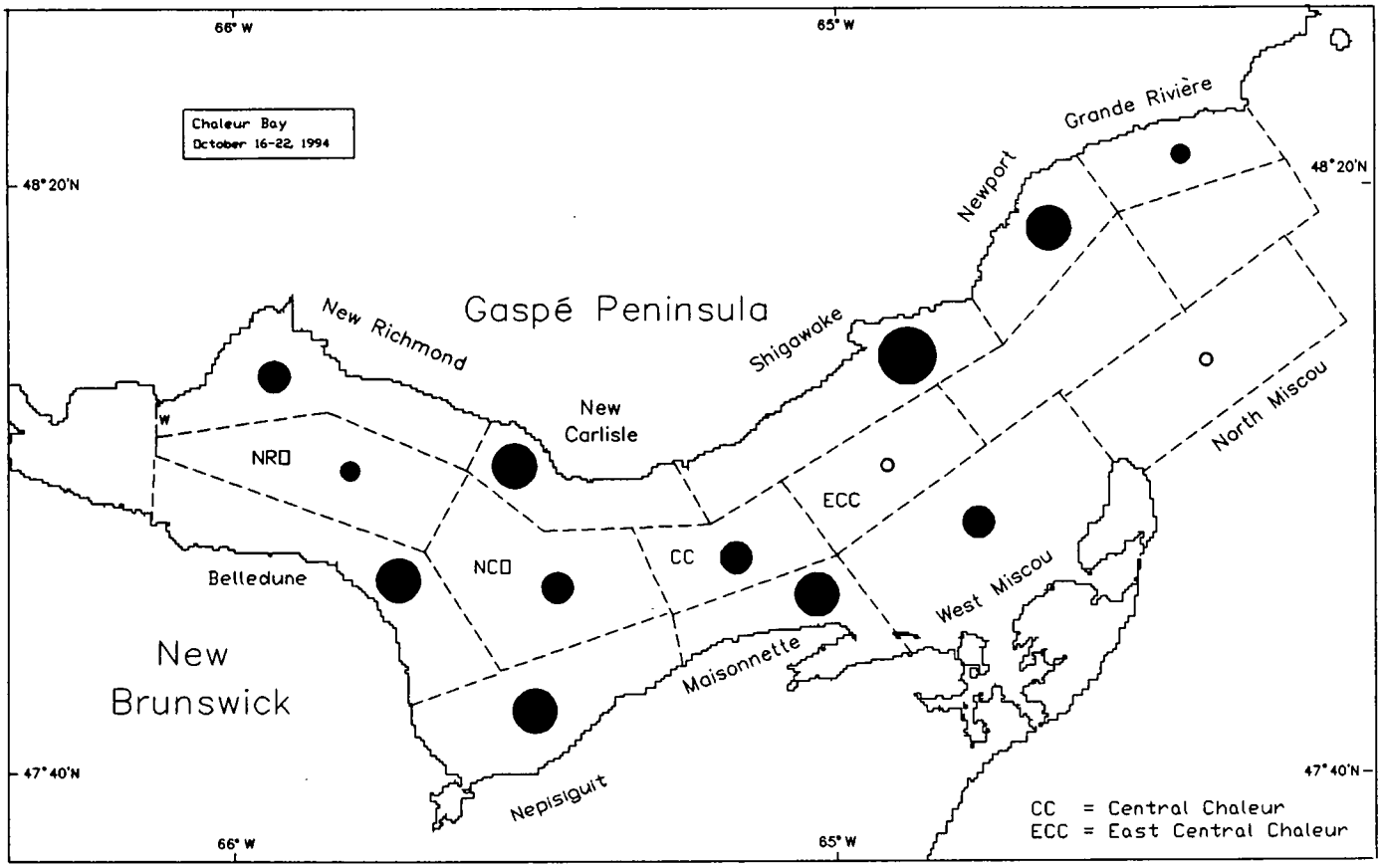
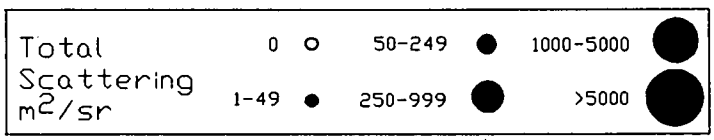
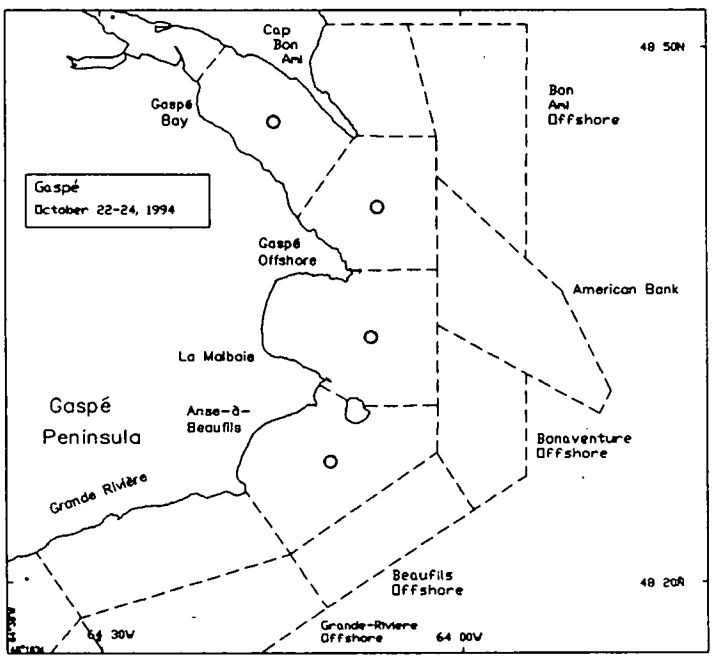


Figure 2. Acoustic transects, herring distribution and set locations in Chaleur Bay, Gaspe and East Miscou strata, October 16-28, 1994.

Figure 2. Lignes du relevé acoustique, distribution du hareng et position des traits effectués dans la baie des Chaleurs, Gaspé et Miscou est, du 16-28 octobre, 1994.







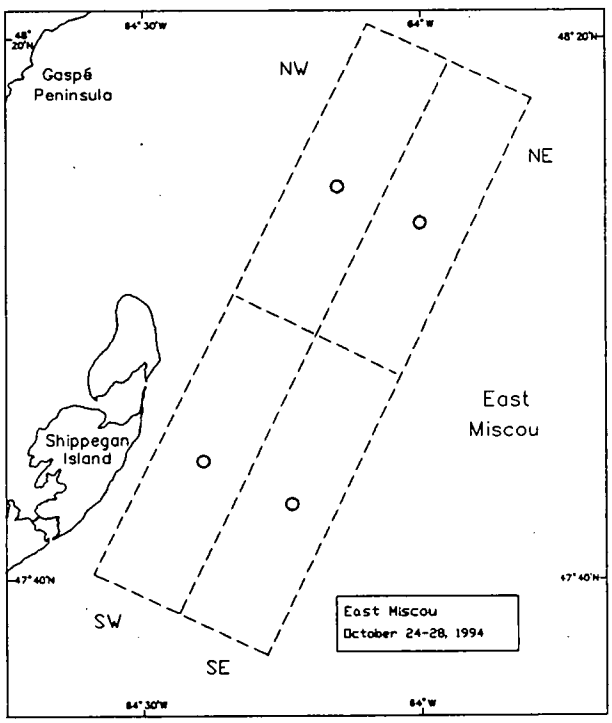


Figure 3. Total herring acoustic scattering (m^2/sr) per strata in Chaleur Bay, Gaspe and East Miscou, October 1994 acoustic survey.

Figure 3. Diffusion acoustic (m^2/sr) du hareng détecté par strate dans la baie des Chaleurs, Gaspé et Miscou est, relevé acoustique d'octobre, 1994.

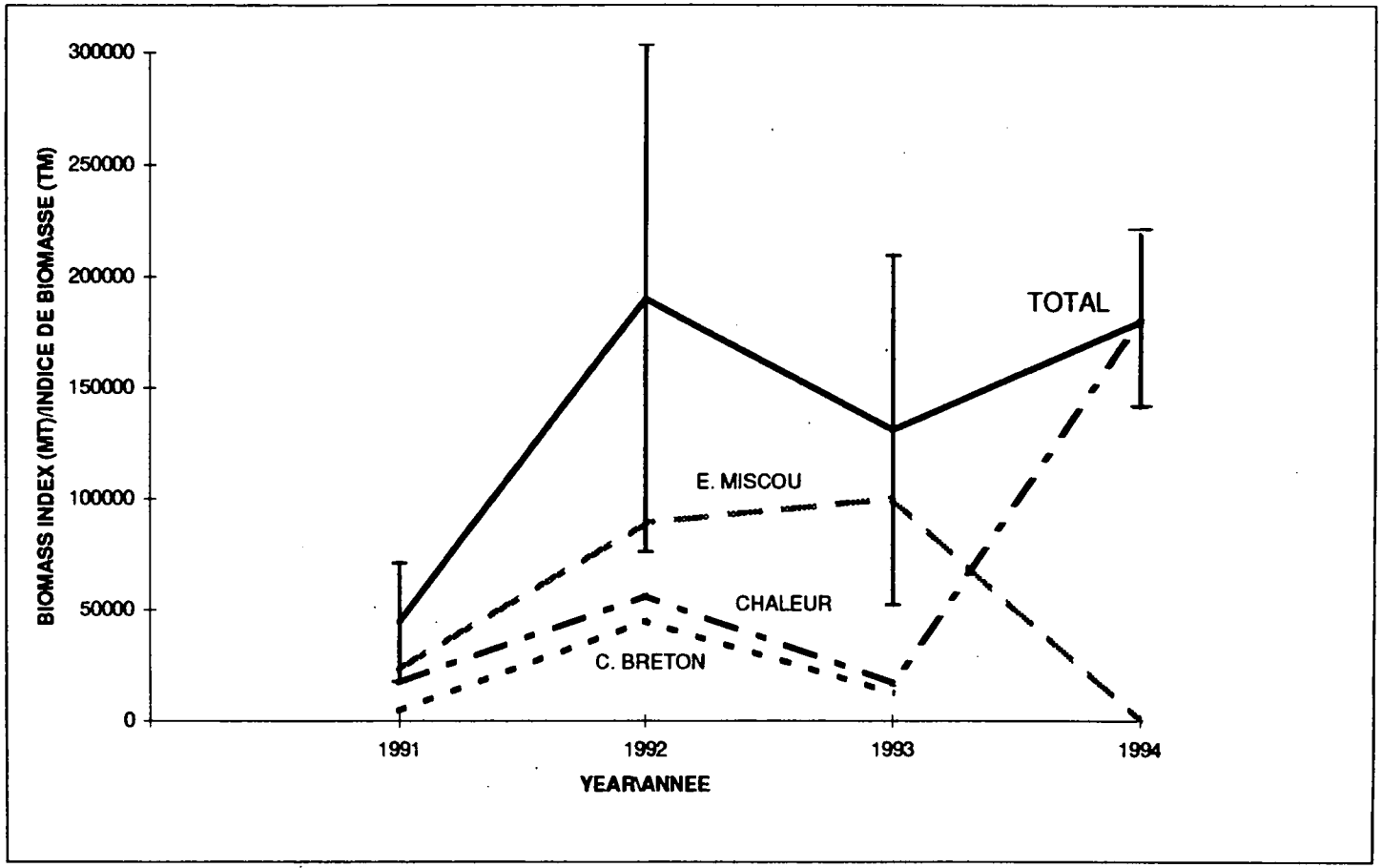
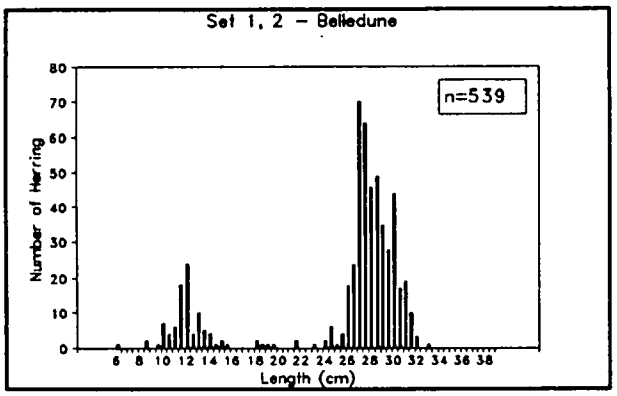
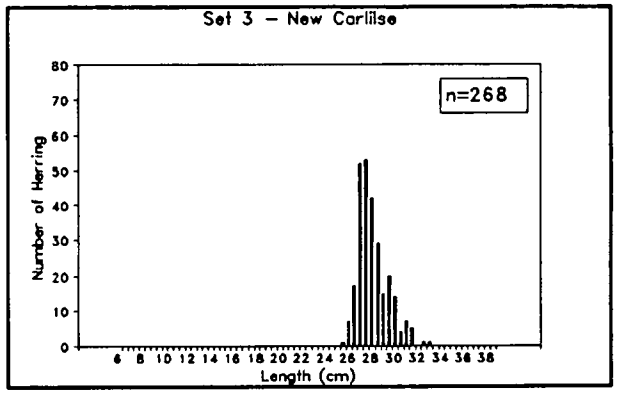
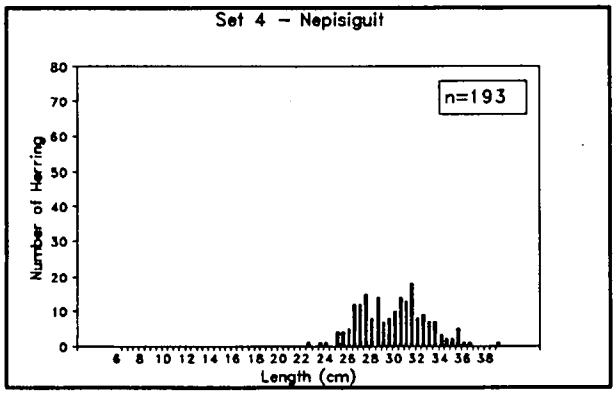
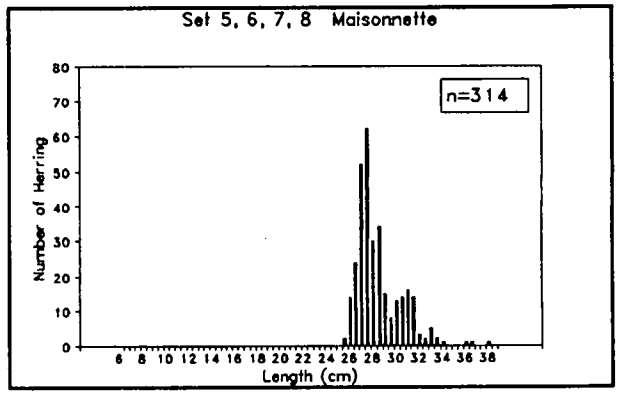


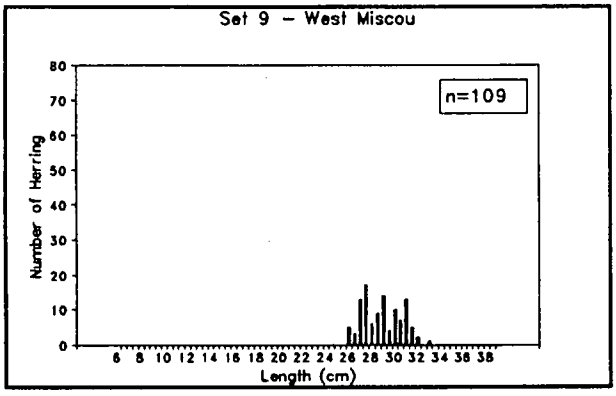
Figure 4. Total and by area biomass estimates, October acoustic surveys, 1991 - 1994.
Figure 4. Estimés de biomasse totale et par region, relevés acoustiques d'octobre, 1991 - 1994.
(Bars are +/- 2 standard errors of TOTAL estimate) (Lignes sont +/- 2 erreurs standards du TOTAL)

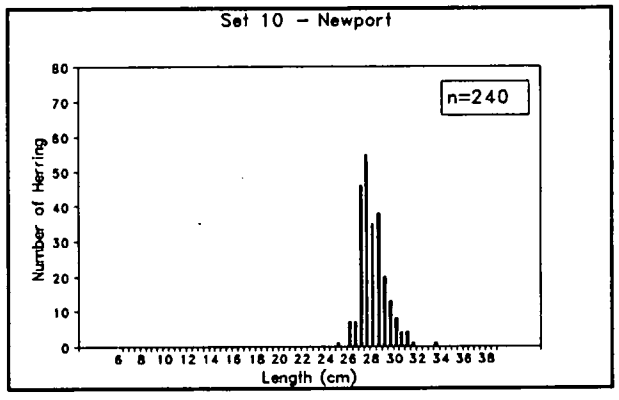












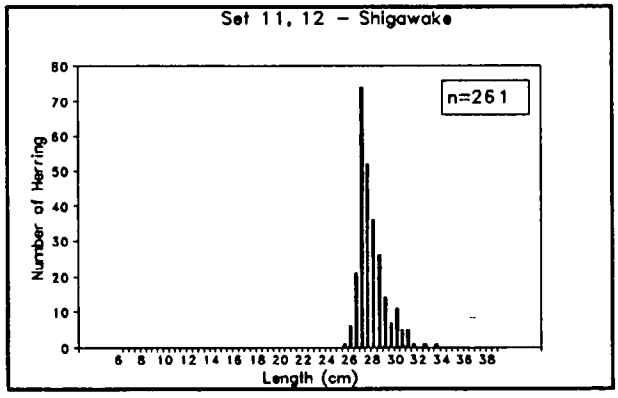


Figure 5. Length frequencies of herring in 1994 acoustic survey trawl sets from Chaleur Bay.
Figure 5. Frequence-longueurs de hareng provenant des échantillons recueillis lors du relevé acoustique de 1994.

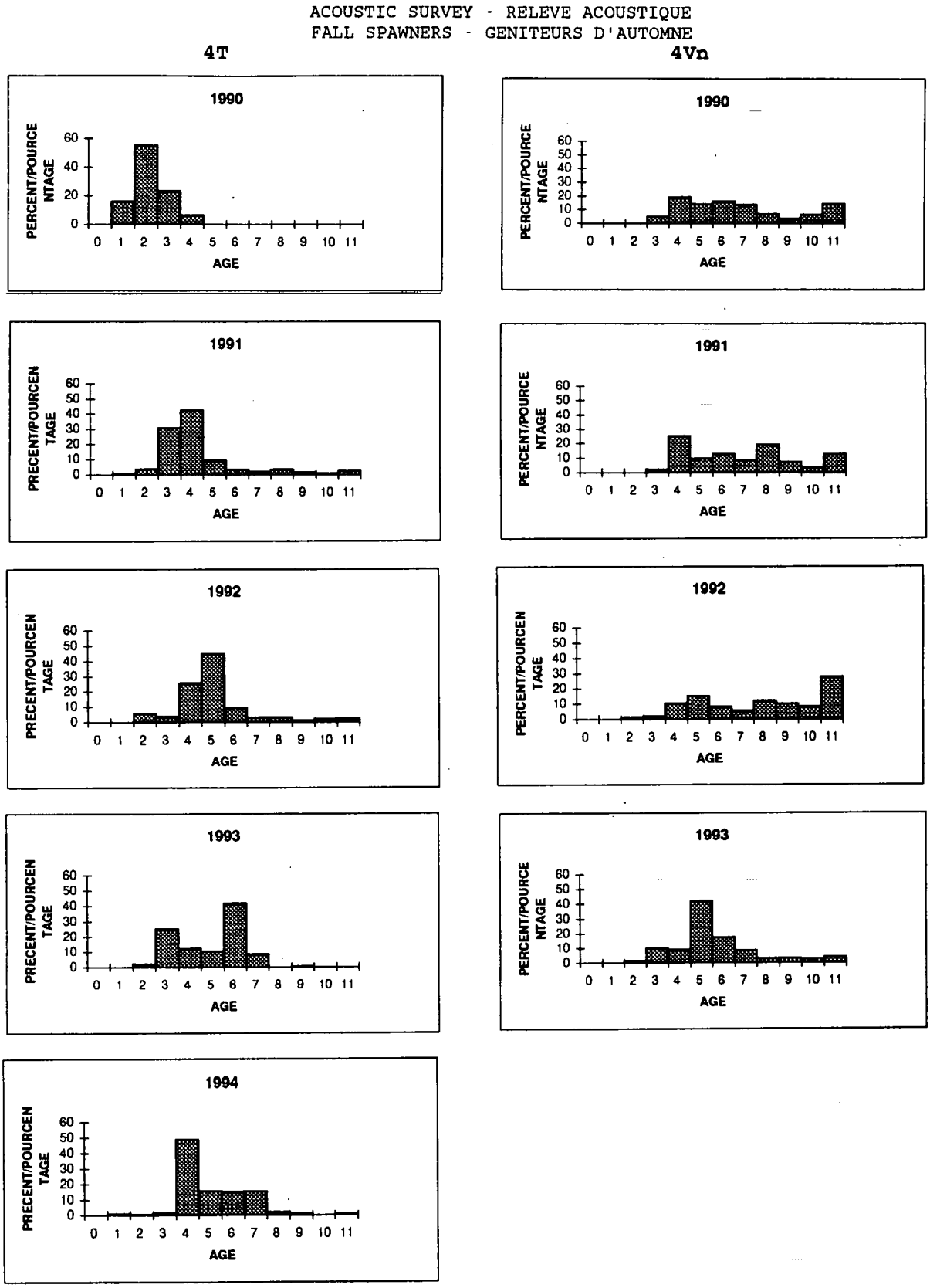


Figure 6a. Fall spawners percent numbers at age by area in 1994 acoustic survey trawl sets.
Figure 6a. Pourcentages de nombres à l'âge des géniteurs d'automne par région, dans les prises de traits de chalut lors du relevé acoustique de 1994.

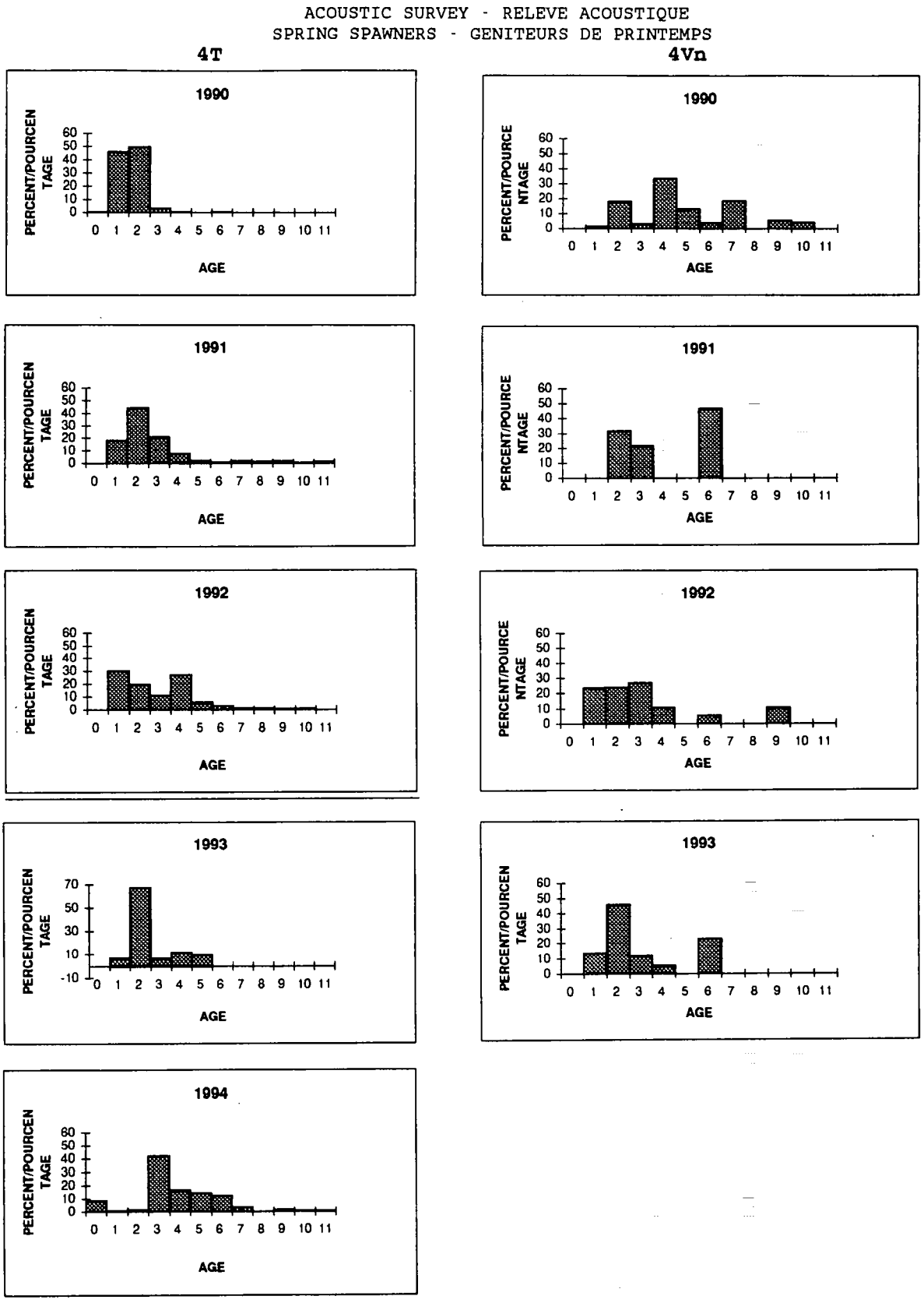


Figure 6b. Spring spawners percent numbers at age by area in 1994 acoustic survey trawl sets.
Figure 6b. Pourcentages de nombres à l'âge des géniteurs de printemps, par région, dans les prises de traits de chalut lors du relevé acoustique de 1994.

Appendix 1. Formulas for target strength, backscatter and biomass calculations.
Annexe 1. Équations utilisées pour le calcul des paramètres de biomasse.

Transect formulas

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

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

$$\text{Average area backscattering (Sa) per transect in dB } m^{-2} = \frac{1}{\text{transect length}} \times \sum \text{Sa per navigational interval weighted by the length of that interval}$$

$$\text{Biomass density per transect in kg } m^{-2} = 10^{\frac{(\text{Average Sa} - \text{Target strength})}{10}}$$

Strata formulas

$$\text{Weighted mean area backscattering (Sa) per stratum in dB } m^{-2} = \frac{1}{\text{total length all transects}} \times \sum \text{Average Sa per transect weighted by the length of that transect}$$

$$\text{Biomass density per stratum in kg } m^{-2} = 10^{\frac{(\text{Weighted mean Sa} - \text{Average target strength})}{10}}$$

$$\text{Biomass per stratum in metric tons} = \text{Stratum area in } km^2 \times \text{Biomass density per stratum in kg } m^{-2} \times 1000$$

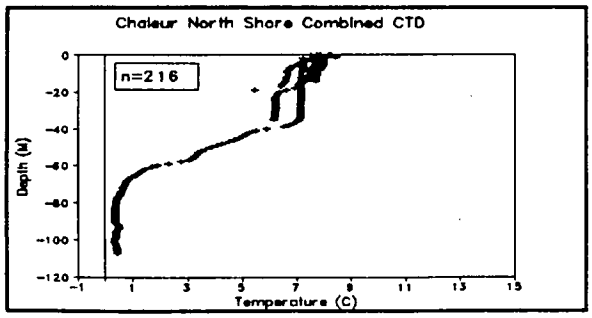
Appendix 2. Mean lengths, weghts and spawning group of herring from herring acoustic survey samples.
Annexe 2. Longueurs et poids moyens, et groupe de géniteurs des échantillons de harengs recueillis lors des traits de chalut des relevés acoustiques.

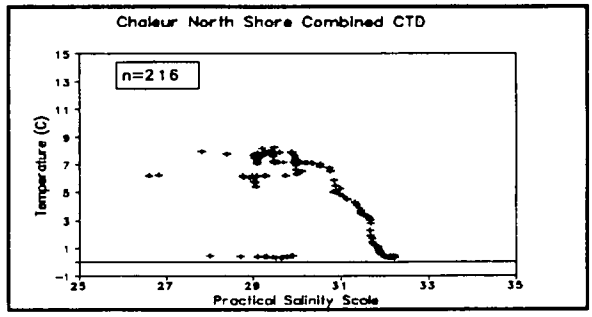
Area and Year	Samples	Mean Length (cm)	Number	Weight at Mean Length (g)	Weight Formula	Percent Fall Spawners by Weight	Target Strength (dB/kg)
CHALEUR							
1994	Chaleur except Belledune	28.4	1385	176.2	$0.00233*len^{3.357}$	68**	-35.3
	Belledune	25.4	539	121.5	$0.00390*len^{3.198}$	68**	-34.6
1993	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
	West***	23.2	1709	89.8	$0.00393*len^{3.192}$	32**	-34.13
CAPE BRETON							
1994	none						
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

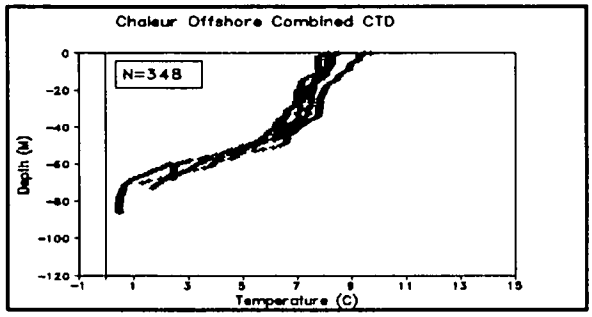
* Juvenile herring samples, New Carlilse & Anse a Beaufils strata

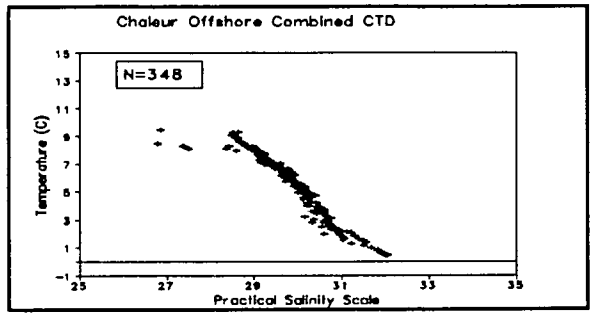
** Percentage represents all Chaleur samples combined

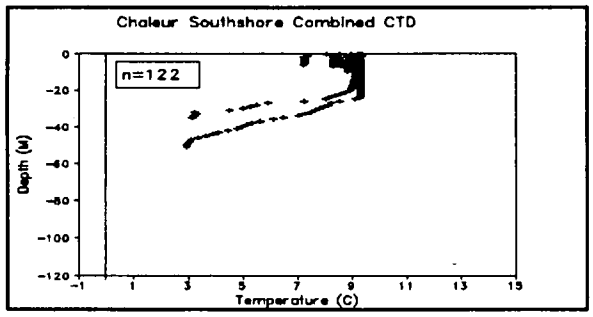
*** Mostly juvenile herring

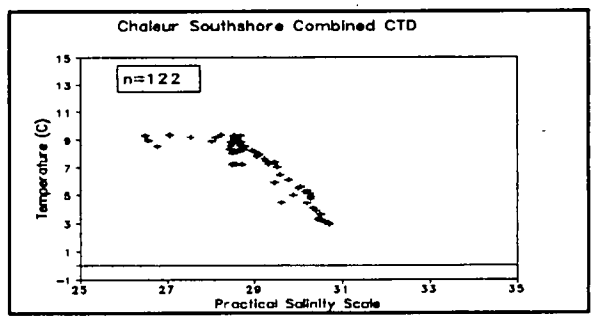


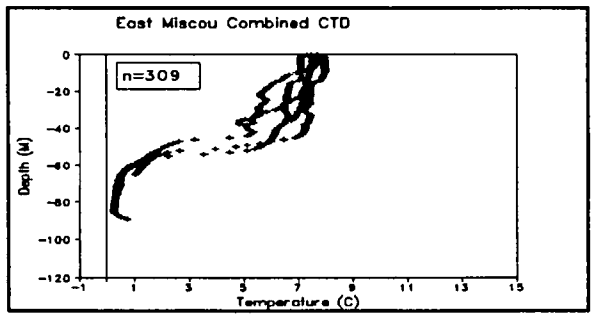


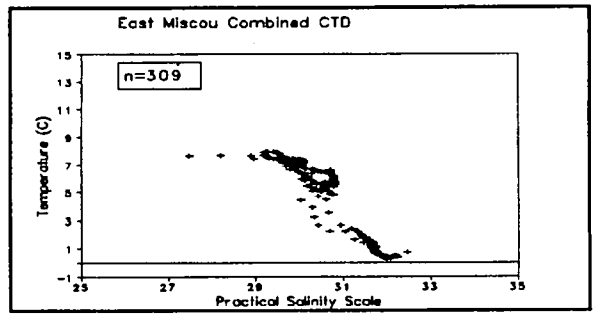


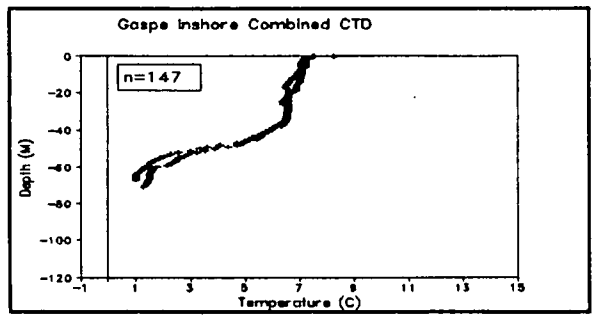


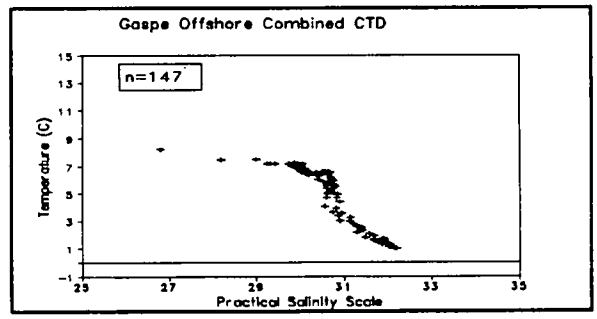




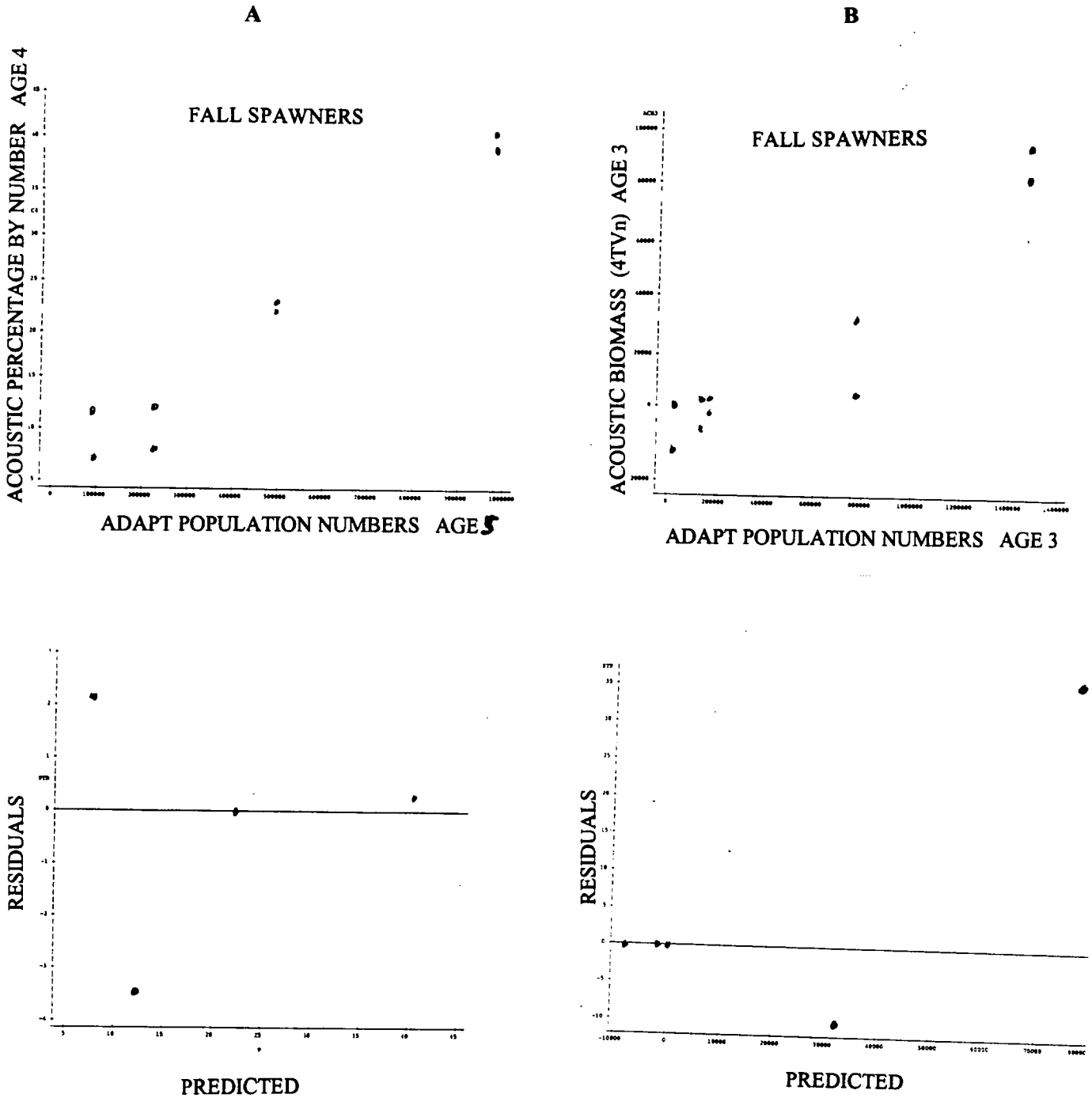








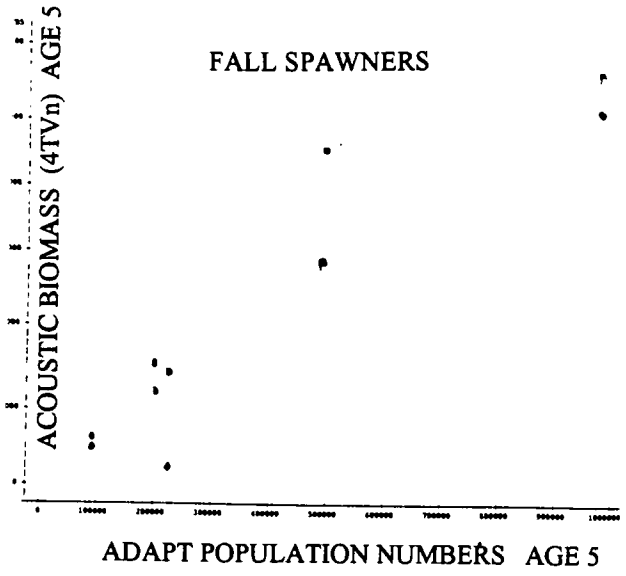
Appendix 3. Temperature and salinity profiles by area from 1994 herring acoustic survey.
Annexe 3. Données de température et salinité recueillies, par région, lors du relevé acoustique de 1994.



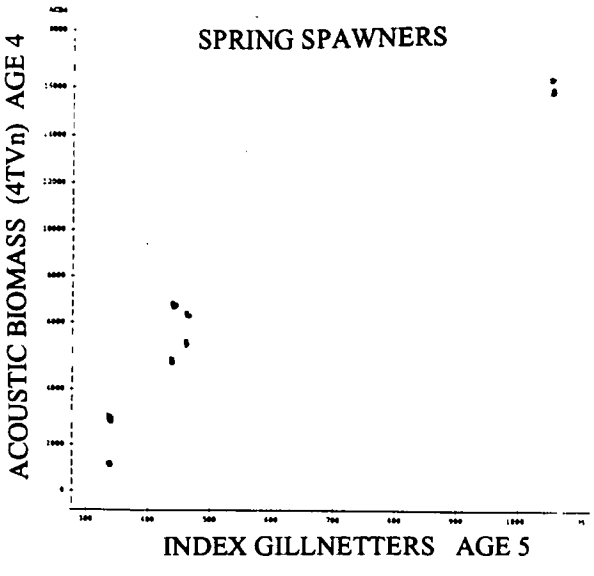
Appendix 4. Scatter and residual plots of GLM procedures for comparisons found to be significant at (pr>F) < 0.05 (see Tables 8a and 8b).

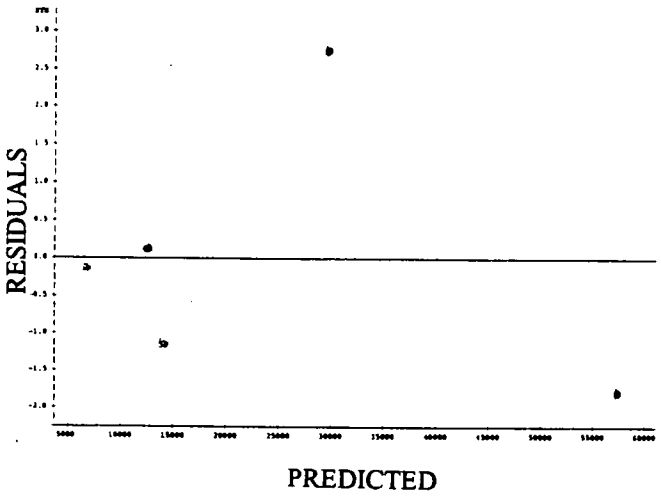
Annexe 4. Graphiques des régressions linéaires pour les comparaisons significatives (pr>F) < 0.05 entre les données des relevés acoustiques et d'autres sources de données (voir Tableaux 8a and 8b).

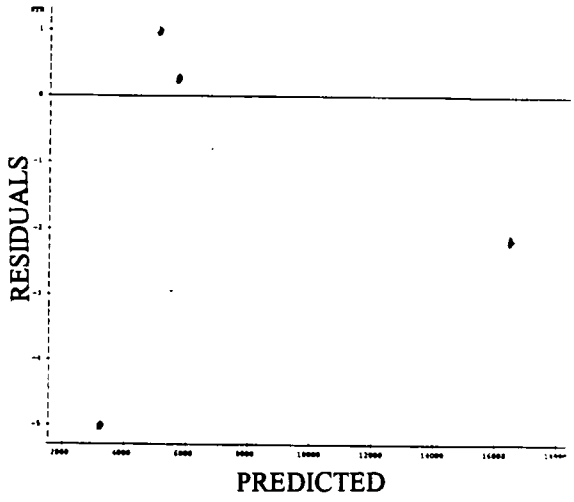
C



D







Appendix / Annexe 4. (con't) (suite)