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Distribution and Acoustic Backscatter of Herring in NAFO Divisions 4T and 4Vn, Sept. 23 - Oct. 08, 1995

by

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ABSTRACT

The 1995 acoustic survey covered Chaleur Bay and the adjacent areas of Miscou and Tracadie, as well as the Cape Breton area (4Vn) and the new added strata of north-eastern PEI (Milne) and George's Bay. The main herring concentrations, representing 70% of the total survey backscatter recorded, were detected in the Northwest Miscou, Maisonnette, and Nepisiguit strata of Chaleur Bay. The 1995 total biomass index of 89,244 tons was the lowest since 1991. The 1995 Chaleur-Miscou inshore area had a lower proportion of transect length with backscatter detected than the 1994 survey. Fall spawners represented 68% of the total backscatter detected in 1995, the dominant year-class being 1990, thus 5 year-olds. This 1990 year class represented close to 38% of fall spawner numbers in 1995. For the spring spawners, the strongest year-class was 1993, being 2 year-olds, which accounted for 40% of the 1995 spring spawner numbers.

RÉSUMÉ

Le relevé acoustique de 1995 a couvert la région de la baie des Chaleurs, incluant les strates de Miscou et Tracadie, ainsi que la région du Cap Breton (4Vn) et les nouvelles régions du nord-est de l'I.P.É et de la baie George. La distribution géographique et la diffusion acoustique des bancs de harengs détectés durant le relevé 1995 indiquent que les strates de Miscou nord-ouest, Maisonnette, et Nepisiquit étaient les principales régions de concentration du hareng, responsables pour 70% du total de la diffusion acoustique. L'estimation de la biomasse d'après l'intensité de la diffusion acoustique est de 89,344 tonnes, valeur inférieure à celles de 1992 à 1994. Pour les strates côtières de la région Chaleur-Miscou, la proportion de distance totale couverte sur laquelle il y avait de la diffusion acoustique présente était inférieure à 1994. Les géniteurs d'automne représentaient 68% de la diffusion acoustique détectée; la classe d'âge dominante étant celle de 1990 à l'âge de 5 ans; celle-ci représentait 38% du nombre total des géniteurs d'automne. La majorité (40% en nombre) des géniteurs de printemps étaient de la classe d'âge de 1993, âgés de 2 ans.

INTRODUCTION

From 1984 to 1989, Gulf Region conducted acoustic surveys of the late fall concentration 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 120 KHz Simrad EY200 echo sounder has been used (LeBlanc, et al. 1993, LeBlanc and Dale 1994, LeBlanc, et al. 1995). Up until 1990, the surveys were held in the month of November. Since 1991, they have been held in October; the 1995 survey starting even earlier on September 23rd.

Survey efforts were concentrated in the Chaleur-Miscou area, as well as the Cape Breton area (4Vn), where NAFO division 4T herring congregate in the fall. The 1995 survey also covered parts of north-eastern Prince Edward Island (Milne strata) and the George's Bay area of Gulf Nova Scotia. This paper describes the distribution and acoustic backscatter of herring signals detected from September 23 to October 8, 1995.

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 (Figures 1 and 2).

Survey time among strata was allocated so that the density of coverage varied with the expected herring biomass index, based on the previous year's results. 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 Miscou and Tracadie 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.

Additional strata were added in the 1995 survey. These are the Tracadie strata covering an area south of the Miscou strata (Figure 1), plus the north-eastern PEI Milne strata and the Gulf Nova Scotia George's Bay area (Figure 2).

Survey Itinerary

Acoustic transects were run from September 23 to October 8th with the research vessel Frederick G. Creed. Acoustic recordings were done entirely at night, from 20:00 to 06:00 hrs., 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 1994 surveys. A second vessel, the Calanus II, was used for fishing. The coverage started with the Milne-George's area, followed by the Cape Breton 4Vn area and Chaleur-Miscou.

Biological Sampling

Fishing for species identification and biological samples was done at night using a 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. The separate length-frequency samples within a stratum were combined in one average length-frequency for the entire stratum.

Spawning group was assigned using a gonado-somatic index (GSI) on fish with maturing gonads. All other herring, namely juveniles and fish with spawning or spent gonads, were classified using otolith shape (juveniles) or visual inspection of gonad stage (spawning or spent fish) (Mowbray and Bourque 1994). Catch-at-age was determined using age-length keys. One age-length key was used for each spawning group.

Acoustic Data Analysis

Equipment and Calibration

The acoustic equipment consisted of a Simrad 120 KHz split beam transducer connected to a Simrad EY200 echo sounder. The signal received by the echosounder was digitized using a Femto model J9001 dual channel digitizer. The transducer was hull mounted on the Frederick G. Creed. This greatly improved transducer stability and signal, especially in inclement weather conditions.

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:

TVG: 20 log R
Equivalent Ideal Beam Angle: -17.5 dB
Pulse Length: 0.3 m sec
Frequency: 120 kHz

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 biomass density and the variance of area biomass indices follow procedures outlined by O'Boyle and Atkinson (1989) and Femto HDPS formats (Appendix 1).

The Chaleeur-Miscou area total distance surveyed and the proportion thereof having herring backscatter was estimated based on the recorded data files of each transect, and these were compared to the 1994 survey to corroborate the differences in the two year's results.

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 target strength value was calculated for each stratum where one or more biological samples were taken. For strata where no biological sample were taken, due to unavailability of fishing vessel or scattered fish signals not successfully fished, target strength was calculated from the mean herring size of the closest successful trawl set from adjoining strata.

RESULTS

Trawl Sets and Sample Composition

Herring lengths, weights and spawning group proportions from the 1993 to 1995 acoustic survey samples are summarised in Appendix 2. The 1995 survey midwater trawl set locations can be found in Figure 3 and are listed in Table 2. The fishing vessel Calanus II was not available for coverage of the Milne-George's Bay area. One midwater trawl set was done in the Aspy Bay stratum of Cape Breton, but no herring was captured.

The corresponding length frequency distributions of herring samples are shown in Figure 5. The length frequency distributions per stratum show that larger herring was caught in the Miscou strata and the eastern part of Chaleur Bay (Newport and Grand-Rivière strata), while smaller adult and juvenile herring were found mainly in the western part of the Bay in the Shigawake, New Carlisle and Maisonnette strata. All areas show a peak mode length at 28 - 29 cm, with a second smaller peak in the western part of the Bay at 24 - 25 cm.

Distribution of Herring and Backscatter Recorded

The distribution of herring encountered during the 1995 survey is mapped in Figure 1 for the Chaleur-Miscou area, and Figure 2 for the Milne-George's Bay and Cape Breton areas. Most of the herring was located in inshore waters parallel to shore on both the northern and southern coast of Chaleur Bay, as well as the northern part of the Miscou strata. The total acoustic scattering intensity of herring detected in each stratum is indicated by relative magnitudes of shading.

The acoustic backscatter recorded per transect within a stratum, in the Chaleeur-Miscou area is summarised in Table 1a, while the Milne-George's area is found in Table 1b and the Cape Breton transects in Table 1c. The highest single transect biomass density was recorded in the Nepisiquit stratum of Chaleur Bay. The two adjoining Maisonnette stratum transects also had high backscatter values, as did transect 152 of the Miscou NW stratum. Two transects in the Milne stratum of eastern PEI and one transect in the Aspy Bay stratum of Cape Breton also showed high backscatter values, but no successful fishing sets could be done in these areas. The remaining transects in these two areas all had low backscatter values.

The per stratum values of biomass density and total biomass index are summarised in Table 2. The Miscou Northwest stratum had the highest recorded biomass with a value of 16,234 metric tons, followed by Nepisiquit stratum with 9,440 tons and Maisonnette with 7,936 tons.

Mean Density and Biomass Index

A summary of the mean biomass density and total biomass index for the Southern Gulf for the years 1991 to 1995 is presented in Table 3. The 1995 total biomass index of 89,244 tons is the lowest value since 1991. The Chaleeur-Miscou inshore area accounted for 70% of this 1995 detected biomass, which was evenly distributed throughout the Chaleeur-Miscou inshore area, as reflected by the low coefficient of variation value for 1995.

Figure 4 gives the relative importance of each area contributing to the total biomass index since 1991. The areas included are the Chaleur Bay strata, the Miscou area and the Cape Breton area. The Milne-George's area is not included since it was not surveyed in the previous years. The relative contribution of each area is different than the 1994 results, when all of the biomass detected was inside Chaleur Bay.

Transect Length with Backscatter Detected

For the same strata covered both in 1994 and 1995, the total transect length surveyed was different by only 2 kilometres, whereas the proportion of total distance with backscatter detected was less in 1995 (0.108) compared to 1994 (0.16)(Table 4). The resulting biomass index reflects this, the 1995 value of 63,676 tons being inferior to the 1994 value of 159,983 tons. The 1995 detected backscatter was less in both intensity and area than the 1994 results.

Catch-at-Age

Catch-at-age matrices, from 1990 to 1995, for 4T, 4Vn and 4TVn combined, weighted by the total backscatter proportions for each area (Chaleeur-Miscou and Cape Breton), are presented in Table 5 for fall spawners and Table 6 for spring spawners. The fall spawners represented 68% of the 1995 total backscatter detected. In 1995, the dominant year-class was 1990, as 5 year-olds. As seen in Figure 6, this 1990 year-class represents close to 38% by number of fall spawners in 1995. It was also seen in 1994 representing 50% of the fall spawners and approximately 25% of the 1993 fall spawner numbers. The numbers at age of the large 1987 year-class represented 40% of the total fall spawner numbers from 1991 to 1993 in 4T, diminishing in 1994 to approximately 20% and representing only 15% of fall spawner numbers in 1995.

For the spring spawners, the strongest year-class was 1993 which accounted for 40% of the 1995 spring spawners as 2 year-olds, followed by the 1991 year-class representing 24% of the spring spawner numbers (Table 6, Figure 7). The strong 1988 year-class represented only 6% of the spring spawner numbers in 1995.

The biomass at age derived from the acoustic estimates are summarised in Table 7 for fall spawners and Table 8 for spring spawners. The 1995 fall spawner biomass at age for area 4T was dominated by the 1990 year-class as 5 year-olds. In the spring spawner biomass at age, the 1991 year-class was the largest by weight.

DISCUSSION

In the 1995 acoustic survey (Sept. 23 to Oct. 08) the main herring concentrations, representing 70% of the total survey backscatter recorded, were detected in the Chaleeur-Miscou inshore strata, the highest per stratum values going to the Miscou Northwest, Nepisiquit and Maisonnette strata. Other areas were the Chaleeur-Miscou offshore strata, including the new Tracadie stratum, which accounted for 10% of the total backscatter, while the Cape Breton area had 8%. Acoustic signals in this area were dispersed and no successful fishing sets could be done. The additional strata off north-eastern PEI (Milne) and George's Bay accounted for 12% of the backscatter detected. This area was surveyed concurrently with the annual groundfish survey which caught herring in their sets over the same area.

To verify the decline in the acoustic biomass index from 1994 to 1995, the actual transect length with backscatter detected was used in strata of the Chaleeur-Miscou area covered both years. This corroborated our lower 1995 estimate as the proportion of transect distance with backscatter was lower.

The acoustic survey biomass index for 1995 was 89,244 tons, the lowest since 1991. If we consider only the traditional strata covered in all years since 1991, 1995 is still the second lowest recorded value of biomass index. Survey coverage has varied over the years. Therefore, comparisons made between years should be done for strata covered in most years, such as Chaleur, Miscou and Cape Breton strata (Table 3, Figure 4). Any overall comparison must take into account the differences in survey coverage.

Few older age-classes of herring were found in the 1995 survey, in comparison with the 1994 survey. The 1995 assessment of the NAFO Division 4T Southern Gulf of St-Lawrence herring stock, using the ADAPT VPA model framework, puts the fall spawner 4+ biomass at 280,000 tons, while the 1994 estimate was 375,000 tons for 5+ biomass. These ADAPT matrices also show a reduction in fall spawner biomass, largely due to the decline of the strong 1987 year-class which contributed to the fishery for the past four years. The spring spawner 4+ biomass was estimated at between 70,000 and 110,000 tons (Claytor, et al., 1996).

For the fall spawners, the acoustic survey samples had low numbers of 4 year-olds, which could indicate a below average recruitment into the fishery for 1996. The same is also apparent for the spring spawners, where there were low numbers of 3 year-olds compared to the 1994 survey.

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LITERATURE CITED

Cairns, D.K., and J.A. Wright. 1990. Distribution and acoustic backscatter of herring in NAFO Division 4T, November 1989. CAFSAC Res. Doc. 90/72.

Cairns, D.K., J.A. Wright, and E.M.P. Chadwick. 1988. Acoustic backscatter estimates and school behaviour of herring in NAFO Divisions 4T and 4Vn, November 1987. CAFSAC Res. Doc. 88/46.

Cairns, D.K., J.A. Wright, and E.M.P. Chadwick. 1989. Distribution and acoustic backscatter of herring in NAFO Divisions 4T and 4Vn, November-December 1988. CAFSAC Res. Doc. 89/42.

Claytor, R., C. LeBlanc, J. Dale, G. Nielsen, L. Paulin, C. Bourque, and C. MacDougall. 1996. Assessment of the NAFO Division 4T Southern Gulf of St. Lawrence herring stock, 1995. DFO Atl. Fish. Res. Doc 96/ (submitted).

Foote, K.G. 1987. Fish target strengths for use in echo integrator surveys. J. Acoust. Soc. Am. 82:981-987.

LeBlanc, C., and J. Dale 1994. Distribution and acoustic backscatter of herring in NAFO divisions 4T and 4Vn, October 1993. DFO Atl. Fish. Res. Doc. 94/44.

LeBlanc, C., A. St.-Hilaire, and J. Dale. 1993. Distribution and acoustic backscatter of herring in NAFO divisions 4T an 4Vn, fall 1990 - 1992. DFO Atl. Fish. Res. Doc. 93/55.

LeBlanc, C., J. Dale, and L. Mello. 1995. Distribution and acoustic backscatter of herring in NAFO division 4T, October 1994. DFO Atl. Fish. Res. Doc. 95/128.

Mowbray, F., and C. Bourque. 1994. Catch-at-age and weight-at-age of Atlantic herring catches in NAFO Divisions 4T and 4Vn, 1978-1993. DFO Atl. Fish. Res. Doc. 94/96.

O'Boyle, R.N., and D.B. Atkinson. 1989. Hydroacoustic survey methodologies for pelagic fish as recommended by CAFSAC. CAFSAC Res. Doc. 89/72.

Shotton, R. 1986. Results of the acoustic survey of herring in the southern Gulf of St. Lawrence and Sydney Bight, November 1985. CAFSAC Res. Doc. 86/84, 40 pp.

Shotton, R., M. Ahrens, and C. Bourque. 1987a. Results of an acoustic survey of herring in the southern Gulf of St. Lawrence and Sydney Bight, November 1984. CAFSAC Res. Doc. 87/63. 22 pp.

Shotton, R., E.M.P. Chadwick, and J.A. Wright. 1987b. Results of the acoustic survey of herring stocks in NAFO divisions 4T and 4Vn November 1986. CAFSAC Res. Doc. 87/88, 22 pp.

Table 1a. Chaleur-Miscou transect backscatter and biomass density, 1995 acoustic survey.
Tableau 1a. Difusion acoustique et densité de biomasse,région Chaleur-Miscou, 1995.

Stratum Date (DD-MM) Location	Transect Number	Transect Length (km)	Target Strength (dB/kg)	Average Sa (dB/m^2)	Biomass Density (Kg/m^2)	Set Number
Tracadie East	80	13.19	-35.78	-54.305	0.014	
28-09	83	12.75	-35.78	-55.283	0.0112	
29-09	84	17.11	-35.78	-54.676	0.0129	
Offshore	90	12.13	-35.78	-59.526	0.0042	
	91	12.67	-35.78	-58.043	0.0059	
	93	11.34	-35.78	-59.469	0.0043	
Tracadie West	81	11.59	-35.78	-67.336	0.0007	
28-09	82	11.67	-35.78	-64.335	0.0014	
29-09	85	13.54	-35.78	-59.709	0.004	
Inshore	89	10.44	-35.78	-57.921	0.0061	
	92	13.00	-35.78	-54.263	0.0142	
	94	13.69	-35.78	-57.865	0.0062	
Miscou South East (SE)	95	12.11	-35.78	-62.291	0.0022	
30-09 / 03-10	96	12.46	-35.78	-61.167	0.0029	
Offshore	142	12.81	-35.78	-62.046	0.0024	
	147	13.22	-35.78	-55.018	0.0119	
Grande-Riviere	100	7.63	-35.15	-57.453	0.0059	
01-10	101	8.04	-35.15	-65.636	0.0009	
02-10	102	7.16	-35.15	-57.076	0.0064	
Inshore	103	8.74	-35.15	-55.098	0.0101	
	104	9.18	-35.15	-71.961	0.0002	
	134	7.93	-35.15	-52.747	0.0174	
	135	7.46	-35.15	-51.971	0.0208	
	136	8.40	-35.15	-51.651	0.0224	4
Shigawake	106	6.26	-34.83	-70.895	0.0002	
01-10	107	6.65	-34.83	-53.359	0.014	
02-10	108	6.83	-34.83	-57.175	0.0058	
Inshore	109	6.19	-34.83	-56.373	0.007	
	110	6.42	-34.83	-56.037	0.0076	
	111	5.93	-34.83	-55.729	0.0081	
	112	6.11	-34.83	-50.761	0.0255	
	113	6.19	-34.83	-45.955	0.0772	
	114	7.05	-34.83	-45.653	0.0827	
	115	6.99	-34.83	-46.385	0.0699	6
	116	7.08	-34.83	-49.379	0.0351	
	117	11.65	-34.83	-52.377	0.0176	
	118	9.25	-34.83	-53.627	0.0132	
	119	7.34	-34.83	-71.691	0.0002	
	120	6.60	-34.83	-74.404	0.0001	
	121	4.95	-34.83	-76.379	0.0001	
	122	6.92	-34.83	-71.722	0.0002	
	123	4.59	-34.83	-52.004	0.0192	5
Newport	124	6.45	-35.46	-52.696	0.0189	
02-10	125	7.27	-35.46	-59.148	0.0043	
Inshore	126	6.77	-35.46	-52.114	0.0216	
	127	6.07	-35.46	-1027.834	0	
	129	9.54	-35.46	-51.583	0.0244	7
	130	9.24	-35.46	-47.726	0.0594	
	131	9.35	-35.46	-45.627	0.0962	
	132	9.21	-35.46	-50.973	0.0281	
	133	8.62	-35.46	-55.99	0.0089	3
Miscou South West (SW)	137	12.88	-35.78	-57.116	0.0074	
03-10	138	13.39	-35.78	-58.51	0.0053	
Inshore	139	12.36	-35.78	-58.379	0.0055	
	141	12.93	-35.78	-57.895	0.0061	
	143	13.51	-35.78	-58.043	0.0059	
	145	13.35	-35.78	-61.123	0.0029	
	148	12.88	-35.78	-67.21	0.0007	

Table 1a. Con't..... Tableau 1a. Suite....

Miscou North West (NW)	149	13.08	-35.78	-50.527	0.0335	
03-10	152	13.27	-35.78	-43.795	0.1579	10
04-10	153	4.73	-35.78	-53.86	0.0156	
Inshore	154	6.74	-35.78	-53.729	0.016	
	155	12.39	-35.78	-66.209	0.0009	
	156	12.90	-35.78	-72.538	0.0002	
	159	12.63	-35.78	-80.537	0	
	160	12.47	-35.78	-73.738	0.0002	
Miscou North East (NE)	150	12.29	-35.78	-56.209	0.0091	8
03-10	151	13.02	-35.78	-56.046	0.0094	9
04-10	157	13.09	-35.78	-68.245	0.0006	
	158	13.35	-35.78	-69.288	0.0004	
	161	12.99	-35.78	-71.474	0.0003	
	162	11.01	-35.78	-69.161	0.0005	
New Carlilse	166	5.97	-35.11	-55.186	0.0098	11
05-10	167	3.60	-35.11	-69.518	0.0004	12
Inshore	169	5.54	-35.11	-55.492	0.0092	13
	170	5.36	-35.11	-54.917	0.0105	14
	171	5.52	-35.11	-56.632	0.007	
	172	8.06	-35.11	-51.526	0.0228	
	174	7.74	-35.11	-49.463	0.0367	
	176	7.94	-35.11	-50.609	0.0282	15
	178	7.37	-35.11	-52.244	0.0193	
New Richmond	179	6.66	-35.11	-60.58	0.0028	
06-10	180	6.02	-35.11	-58.907	0.0042	
Inshore	181	6.42	-35.11	-61.751	0.0022	
	183	6.78	-35.11	-55.876	0.0084	
	184	9.67	-35.11	-55.57	0.009	
	186	6.43	-35.11	-57.089	0.0063	
Belledune	188	6.17	-35.28	-56.28	0.0079	
06-10	190	5.51	-35.28	-59.501	0.0038	
Inshore	193	4.78	-35.28	-69.082	0.0004	
	194	7.23	-35.28	-54.769	0.0112	
	196	7.89	-35.28	-54.941	0.0108	
	197	8.47	-35.28	-51.275	0.0252	
Maisonnette	200	8.12	-35.28	-83.85	0	
07-10	201	6.68	-35.28	-68.071	0.0005	
08-10	202	6.14	-35.28	-58.454	0.0048	
Inshore	203	6.30	-35.28	-48.966	0.0428	
	204	5.70	-35.28	-43.452	0.1523	
	205	5.34	-35.28	-48.123	0.052	
	206	5.83	-35.28	-46.045	0.0838	
	207	5.36	-35.28	-46.994	0.0674	
	208	4.73	-35.28	-47.404	0.0613	
	209	4.93	-35.28	-48.172	0.0514	16
	210	4.99	-35.28	-48.977	0.0427	
	212	4.75	-35.28	-44.765	0.1126	17
	214	5.08	-35.28	-44.021	0.1336	18
Nepisiguit	216	5.45	-35.28	-40.833	0.2784	
08-10	217	6.93	-35.28	-47.643	0.058	
Inshore	218	6.73	-35.28	-52.234	0.0202	
	219	8.83	-35.28	-59.783	0.0035	
	220	10.41	-35.28	-57.316	0.0063	
	221	11.40	-35.28	-53.465	0.0152	
	222	10.65	-35.28	-52.372	0.0195	
	224	9.26	-35.28	-53.925	0.0137	
	225	9.70	-35.28	-59.757	0.0036	

Table 1b. Milne-George's transect backscatter and biomass density, Sept. 23-24, 1995.
Tableau 1b. Difusion acoustique et densité de biomasse, Milne-George, 23-24 sept., 1995.

Stratum Date (DD-MM) Location	Transect Number	Transect Length (km)	Target Strength (dB/kg)	Average Sa (dB/m^2)	Biomass Density (Kg/m^2)	Set Number
Milne Inshore	5	5.19	-35.3	-51.031	0.0267	
23-09	6	4.00	-35.3	-50.99	0.027	
	7	4.11	-35.3	-46.337	0.0788	
	8	4.40	-35.3	-47.078	0.0664	
	9	3.84	-35.3	-49.561	0.0375	
	10	4.83	-35.3	-51.457	0.0242	
	11	2.69	-35.3	-52.37	0.0196	
Milne Offshore	12	6.31	-35.3	-58.07	0.0053	
23-09	13	4.51	-35.3	-59.924	0.0034	
	15	4.57	-35.3	-64.853	0.0011	
	16	5.13	-35.3	-52.346	0.0197	
East St Georges	17	21.06	-35.3	-61.535	0.0024	
23-09	18	19.81	-35.3	-63.811	0.0014	
Inshore	19	19.53	-35.3	-64.36	0.0012	
	20	11.76	-35.3	-64.222	0.0013	
West St Georges	21	10.55	-35.3	-65.018	0.0011	
24-09	22	20.73	-35.3	-61.994	0.0021	
Cape George	23	2.10	-35.3	-63.802	0.0014	
24-09	24	6.27	-35.3	-67.944	0.0005	
Inshore	25	10.90	-35.3	-63.324	0.0016	
	26	10.78	-35.3	-62.954	0.0017	

Table 1c. Cape Breton transect backscatter and biomass density, Sept. 25-27, 1995.
Tableau 1b. Difusion acoustique et densité de biomasse, Cap Breton, 25-27 sept., 1995.

Stratum Date (DD-MM) Location	Transect Number	Transect Length (km)	Target Strength (dB/kg)	Average Sa (dB/m^2)	Biomass Density (Kg/m^2)	Set Number
Aspy Bay	31	2.24	-35.3	-43.501	0.1513	
25-09	33	5.56	-35.3	-47.554	0.0595	2
Inshore	34	9.62	-35.3	-71.743	0.0002	
	36	10.15	-35.3	-56.972	0.0068	
	38	10.87	-35.3	-56.527	0.0075	
	39	6.89	-35.3	-61.821	0.0022	
	40	9.29	-35.3	-54.315	0.0125	
	42	3.26	-35.3	-63.287	0.0016	
Neil Harbour	43	8.29	-35.3	-49.351	0.0393	
25-09	45	9.17	-35.3	-56.562	0.0075	
26-09	46	10.32	-35.3	-54.901	0.011	
Inshore	47	6.77	-35.3	-59.427	0.0039	
	49	11.62	-35.3	-72.793	0.0002	
	50	13.57	-35.3	-75.56	0.0001	
	51	15.38	-35.3	-60.823	0.0028	
	52	14.16	-35.3	-58.463	0.0048	
Wreck Cove	54	5.81	-35.3	-66.613	0.0007	
26-09	55	7.28	-35.3	-55.055	0.0106	
	56	8.48	-35.3	-78.49	0	
St Anns	57	7.92	-35.3	-69.706	0.0004	
26-09	58	6.95	-35.3	-66.586	0.0007	
Inshore	59	7.07	-35.3	-62.491	0.0019	
	60	6.15	-35.3	-69.103	0.0004	
Haddock Bank	61	12.05	-35.3	-69.227	0.0004	
26-09	63	14.37	-35.3	-68.107	0.0005	
Inshore	64	8.34	-35.3	-66.56	0.0007	
	65	8.30	-35.3	-65.044	0.0011	
Sydney	66	7.90	-35.3	-49.982	0.034	
26-09	67	12.38	-35.3	-63.169	0.0016	
Inshore	68	11.35	-35.3	-60.854	0.0028	
	69	14.28	-35.3	-58.626	0.0046	
New Waterford	71	8.73	-35.3	-54.131	0.0131	
27-09	73	7.38	-35.3	-82.654	0	
Inshore	74	9.09	-35.3	-71.017	0.0003	
	75	7.81	-35.3	-61.344	0.0025	

Table 2. 1995 acoustic survey stratum and per area biomass densities and estimates.
Tableau 2. Densités et estimés de biomasse par strate et région, relevé acoustique de 1995.

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 Index Per Stratum: Total metric tons	SE tons	SE % of Total	Set Number
CHALEUR-MISCOU INSHORE									
6	Grande Riviere	-35.1	173.8	-54.99	0.0104	1803	535	30	4
7	Newport	-35.5	187.0	-50.42	0.0319	5970	1906	32	5,6
8	Shigawake	-34.8	323.3	-51.50	0.0215	6959	2078	30	3,7
9	New Carlilse	-35.1	167.0	-52.51	0.0182	3042	645	21	11 to 15
10	New Richmond	-35.1	253.6	-57.49	0.0058	1465	297	20	
11	Belledune	-35.3	348.0	-54.76	0.0113	3923	1216	31	
12	Nepisiguit	-35.3	278.0	-49.97	0.034	9440	8204	87	
13	Maisonnette	-35.3	137.5	-47.67	0.0577	7936	1849	23	16,17,18
14	Miscou NW	-35.8	524.0	-50.87	0.031	16234	9970	61	10
15	Miscou SW	-35.8	524.0	-58.93	0.0048	2537	447	18	
16	Tracadie West	-35.8	524.0	-58.32	0.0056	2920	1040	36	
	INSHORE TOTAL		3440.2		MEAN DENSITY 0.01809	62229 C.V.=	13477 0.22		
CHALEUR-MISCOU OFFSHORE									
17	Miscou NE	-35.8	524.0	-60.50	0.0034	1769	972	55	8,9
18	Miscou SE	-35.8	524.0	-58.83	0.005	2598	1236	48	
19	Tracadie East	-35.8	524.0	-56.17	0.0091	4789	955	20	
	OFFSHORE TOTAL		1572.0		MEAN DENSITY 0.00583	9156 C.V.=	1840 0.2		
MILNE-GEORGES									
20	Milne-In	-35.3	187.7	-49.23	0.0405	7598	1642	22	
21	Milne-Off	-35.3	203.4	-56.51	0.0076	1538	855	56	
22	E St Georges	-35.3	303.2	-63.19	0.0016	485	—	—	
23	W St Georges	-35.3	326.9	-62.80	0.0018	588	—	—	
24	Cape George	-35.3	253.0	-63.84	0.0014	354	—	—	
	MILNE-GEORGES TOTAL		1274.2		MEAN DENSITY 0.0083	10564			
CAPE BRETON									
29	Aspy Bay	-35.3	168.3	-53.10	0.0166	2794	3133	112	2
30	Neil Harbour	-35.3	259.5	-56.69	0.0073	1885	1184	63	
31	Wreck Cove	-35.3	109.7	-59.51	0.0038	416	373	90	
32	St Anns	-35.3	159.0	-65.97	0.0009	136	57	42	
33	Haddock Bank	-35.3	94.9	-67.26	0.0006	60	14	23	
34	Sydney	-35.3	168.6	-56.04	0.0084	1421	1311	92	
35	New Waterford	-35.3	141.3	-59.14	0.0041	583	437	75	
	CAPE BRETON TOTAL		1101.3		MEAN DENSITY 0.00663	7295 C.V.=	3643 0.5		

Table 3. Total biomass density and estimates from herring acoustic surveys in the Southern Gulf of St. Lawrence, 1991-1995.
Tableau 3. Densités et estimés totales de biomasse provenant des relevés acoustiques dans le sud du golfe du Saint.-Laurent, 1991-199

Year and Dates	Area	Number of Transects	* Proportion covered at night	Mean Density (Kg/m²)	Estimated Biomass Index (t/area)	C.V.	Proportion * recorded at night
1995	CHALEUR-MISCOU INSHORE #	98	1.0	0.0181	62229	0.22	1.0
Sept 23-	CHALEUR-MISCOU OFFSHORE ##	18	1.0	0.0058	9156	0.20	1.0
Oct 08	MILNE - GEORGES	21	1.0	0.0083	10564	--	1.0
	CAPE BRETON INSHORE	35	1.0	0.0066	7295	0.50	1.0
	CAPE BRETON OFFSHORE	--	--	--	--	--	--
	1995 TOTAL ***	172	1.0	0.0121	89244	0.16	1.0
@ 1994	CHALEUR-MISCOU INSHORE +	106	1.0	0.0415	162585	0.11	1.0
Oct	CHALEUR-MISCOU OFFSHORE ++	27	1.0	0.0063	16838	0.34	1.0
16-28	CAPE BRETON INSHORE	--	--	--	--	--	--
	CAPE BRETON OFFSHORE	--	--	--	--	--	--
	1994 TOTAL ** ***	133	1.0	0.0272	179423	0.10	1.0
1993	CHALEUR-MISCOU INSHORE +	163	0.71	0.0202	114052	0.35	0.93
Oct	CHALEUR-MISCOU OFFSHORE ++	45	0.02	0.001	4284	0.41	0
12-20	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
	1993 TOTAL ** ***	338	0.58	--	130848	0.31	0.85
1992	CHALEUR-MISCOU INSHORE	216	0.57	0.0207	48258	0.10	0.65
Oct	CHALEUR-MISCOU OFFSHORE +++	102	0.48	0.0078	96582	0.52	0.75
01-22	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-MISCOU INSHORE	158	0.59	0.0054	16724	0.46	0.87
Oct	CHALEUR-MISCOU OFFSHORE +++	50	0.32	0.0015	23214	0.55	0.65
10-24	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. **Milne strata not included
* Proportion of transects covered and biomass detected during nighttime hours, 1900 to 0700 HR.
*** Laurentian strata not included + Includes Miscou subdivisions NW & SW
++ Includes Miscou subdivisions NE & SE +++ Includes Miscou unsubdivided
# Includes Miscou NW & SW and Tracadie West ## Includes Miscou NE & SE and Tracadie East

Table 4. Chaleur-Miscou comparison of transect distance with backscatter detected and resulting biomass estimates, 1994-95.

Tableau 4. Comparaison de la diistance avec difusion acoustique détectée et la biomasse résultante, région Chaleur-Miscou, 1994-95.

Stratum Name	Distance (km) with backscatter	Transect Length (km)	Proportion of total distance with backscatter	Biomass Index per stratum tons
CHALEUR-MISCOU 1995 SURVEY				
Grande Riviere	4.10	64.54	0.064	1803
Shigawake	12.95	122.99	0.105	6959
Newport	7.81	72.52	0.108	5970
New Carlilse	15.10	57.10	0.264	3042
New Richmond	0.60	41.97	0.014	1465
Belledune	3.40	40.05	0.085	3923
Maisonnette	5.55	73.94	0.075	7936
Nepisiguit	20.10	79.37	0.253	9440
E Miscou SE	4.20	50.60	0.083	2598
E Miscou SW	0.60	91.29	0.007	2537
E Miscou NW	14.60	88.19	0.166	16234
E Miscou NE	3.90	75.74	0.051	1769
1995 TOTAL	92.91	858.28	0.108	63676
CHALEUR-MISCOU 1994 SURVEY				
Grande_Riviere	0.40	61.39	0.007	895
Shigawake	33.60	100.20	0.335	55252
Newport	5.40	85.63	0.063	9497
New_Carlilse	27.80	68.52	0.406	14533
New_Richmond	1.30	84.54	0.015	3524
Belledune	17.10	53.42	0.320	23978
Maisonnette	15.90	69.60	0.228	22003
Nepisiguit	35.10	66.32	0.529	30301
East_Miscou_NW	0	75.96	0.000	0
East_Miscou_NE	0	78.32	0.000	0
East_Miscou_SW	0	61.73	0.000	0
East_Miscou_SE	0	50.47	0.000	0
1994 TOTAL	136.60	856.10	0.160	159983

Table 5. Catch-at-age matrices for herring FALL spawners, by NAFO area, from acoustic surveys, 1990-1995. Values are in numbers at age weighted by acoustic biomass estimate.
Tableau 5. Nombres à l'âge de harengs géniteurs d'AUTOMNE, par zone de l'OPANO, d'après la biomasse estimée lors des relevés acoustiques, 1990-1995.

Fall spawners NAFO 4T	AGE	1990	1991	1992	1993	1994	1995
	0	0	0	0	0	0	0
	1	428444	943	0	0	4023	59
	2	1484657	5478	29832	8461	2995	16977
	3	633917	46376	19596	108416	9135	22111
	4	166696	64120	138894	52489	338873	12927
	5	0	14433	242378	44657	106755	91421
	6	0	4793	48766	181170	103504	17178
	7	0	3128	16274	35855	106099	36164
	8	0	4705	15498	0	13468	35111
	9	0	2707	5866	2050	7204	4557
	10	0	1078	10754	0	0	956
	11+	0	3572	11918	0	4534	487
NAFO 4T Total Number		2713713	151335	539775	433099	696590	237949

Fall spawners NAFO 4Vn	AGE	1990	1991	1992	1993	1994	1995
	0	0	0	0	0	--	--
	1	0	0	0	0	--	--
	2	0	11	2127	701	--	--
	3	22636	346	3258	5617	--	--
	4	87570	4064	16272	5091	--	--
	5	65477	1534	23641	23654	--	--
	6	74906	2066	12677	9796	--	--
	7	63303	1338	8657	4747	--	--
	8	31359	3109	18830	1743	--	--
	9	17351	1151	15545	1761	--	--
	10	29416	527	12682	1430	--	--
	11+	66849	2039	43215	2168	--	--
NAFO 4Vn Total Number		458867	16182	156904	56708		

Fall spawners Total NAFO 4TVn	AGE	1990	1991	1992	1993	1994	1995
	0	0	0	0	0	--	--
	1	428444	943	0	0	--	--
	2	1484657	5489	31959	9162	--	--
	3	656553	46722	22854	114034	--	--
	4	254265	68183	155166	57580	--	--
	5	65477	15967	266018	68311	--	--
	6	74906	6858	61443	190966	--	--
	7	63303	4466	24931	40602	--	--
	8	31359	7814	34328	1743	--	--
	9	17351	3858	21411	3811	--	--
	10	29416	1605	23436	1430	--	--
	11+	66849	5610	55134	2168	--	--
NAFO 4TVn Total Number		3172580	167517	696679	489806		

Table 6 . Catch-at-age matrices from SPRING spawning herring, by NAFO area, from acoustic surveys 1990 - 1995. Values are in number at age weighted by acoustic biomass estimate.
Tableau 6. Nombres à l'âge de harengs géniteurs de PRINTEMPS, par zone de l'OPANO, d'après la biomassse estimée lors des relevés acoustiques, 1990-1995.

Spring spawners NAFO 4T	AGE	1990	1991	1992	1993	1994	1995
	0	29335	0	0	0	28994	186
	1	2875986	15299	91349	23362	748	17561
	2	3112748	37000	59770	234348	3987	57445
	3	182087	17476	33459	21532	143019	6338
	4	12150	6386	81373	39138	56129	34369
	5	5595	1753	18129	31446	47865	2623
	6	15907	824	9172	0	41505	13666
	7	0	1329	3316	0	10199	8205
	8	0	945	3617	0	564	2884
	9	5595	1267	2024	0	3592	1242
	10	0	431	2455	0	1698	0
	11+	0	863	0	0	1764	0
NAFO 4T Total Number		6239404	83575	304664	349826	340063	144520

Spring spawners NAFO 4Vn	AGE	1990	1991	1992	1993	1994	1995
	0	0	0	0	0	--	--
	1	582	0	2850	837	--	--
	2	8051	64	2894	2871	--	--
	3	1333	44	3230	745	--	--
	4	14756	0	1277	332	--	--
	5	5838	0	0	0	--	--
	6	1670	96	622	1434	--	--
	7	8142	0	0	0	--	--
	8	0	0	0	0	--	--
	9	2382	0	1293	0	--	--
	10	1734	0	0	0	--	--
	11+	0	0	0	0	--	--
NAFO 4Vn Total Number		44488	204	12166	6219		

Spring spawners Total NAFO 4TVn	AGE	1990	1991	1992	1993	1994	1995
	0	29335	0	0	0	--	--
	1	2876569	15299	94199	24199	--	--
	2	3120799	37064	62664	237218	--	--
	3	183420	17520	36689	22277	--	--
	4	26906	6386	82649	39470	--	--
	5	11433	1753	18129	31446	--	--
	6	17576	920	9794	1434	--	--
	7	8142	1329	3316	0	--	--
	8	0	945	3617	0	--	--
	9	7977	1267	3317	0	--	--
	10	1734	431	2455	0	--	--
	11+	0	863	0	0	--	--
NAFO 4TVn Total Number		6283892	83778	316830	356044		

Table 7. Biomass (t) at age matrices for FALL spawners by NAFO area, derived from acoustic survey estimates, 1990-95.

Tableau 7. Biomasse à l'âge (tonnes) pour les géniteurs d'AUTOMNE, par zone de l'OPANO, obtenue des estimations de relevés acoustiques, 1990-95.

FALL Spawners NAFO 4T	AGE	1990	1991	1992	1993	1994	1995
	0	0	0	0	0	0	0.0
	1	16280.9	26.4	0	0	53.9	2.4
	2	126195.8	482.1	2088.2	592.3	237.5	1074.7
	3	86212.7	6399.9	2567	13009.9	1230.4	2509.6
	4	27004.7	11349.2	23612	7348.5	52423.6	2208.0
	5	0	2930	46536.5	8484.9	18105.7	16291.2
	6	0	1155	10826	36233.9	20328.2	3198.5
	7	0	850.7	3971	8246.7	22715.7	8053.8
	8	0	1435.2	4448	0	3212.2	8233.5
	9	0	831.2	1548.5	635.5	1979.7	1280.0
	10	0	362.3	3258.4	0	0	303.2
	11	0	1335.8	3980.7	0	1720.6	144.7
Total Biomass		255694.1	27157.8	102836.4	74551.7	122007.6	43299.7

FALL Spawners NAFO 4Vn	AGE	1990	1991	1992	1993	1994	1995
	0	0	0	0	0	--	--
	1	0	0	0	0	--	--
	2	0	1.2	146.8	56.1	--	--
	3	3916.1	57.4	426.8	730.3	--	--
	4	18214.5	820.8	2929	814.5	--	--
	5	14732.3	349.7	4964.5	4494.2	--	--
	6	20299.6	504	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	457.6	--	--
	11	23330.3	727.9	15082.2	715.5	--	--
Total Biomass		124429.1	4373.8	43051.2	11511	--	--

FALL Spawners NAFO4TVn	AGE	1990	1991	1992	1993	1994	1995
	0	0	0	0	0	--	--
	1	16280.9	26.4	0	0	--	--
	2	126195.8	483.3	2235	648.4	--	--
	3	90128.8	6457.3	2993.8	13740.2	--	--
	4	45219.2	12170	26540.9	8163	--	--
	5	14732.3	3279.7	51501	12979.1	--	--
	6	20299.6	1659	13881.3	38291.1	--	--
	7	18484.4	1232.1	6031.2	9433.3	--	--
	8	9407.8	2398.8	9946.3	453.3	--	--
	9	5777.8	1224.7	6289.8	1181.3	--	--
	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	--	--
Fall proportion		0.41	0.71	0.77	0.66	0.68	0.68

Table 8. Biomass (t) at age matrices for SPRING spawners, by NAFO area, derived from acoustic survey estimates, 1990-95.

Tableau 8. Biomasse à l'âge (tonnes) pour les géniteurs de PRINTEMPS par zone de l'OPANO, obtenue des estimations de relevés acoustiques 1990-95.

SPRING Spawners NAFO 4T	AGE	1990	1991	1992	1993	1994	1995
	0	674.7	0	0	0	350.8	2.1
	1	184063.1	1254.5	5572.3	1635.3	37	1006.2
	2	323725.8	4884.1	5200	25778.3	432.6	5819.1
	3	25128	2918.5	5253.1	2799.2	22840.1	833.4
	4	2830.9	1341.1	15867.7	6653.5	9777.6	6334.2
	5	1415.6	415.5	4079.1	6918.1	9285.7	533.6
	6	3738.1	244.7	2283.9	0	9596	2815.3
	7	0	390.8	789.2	0	2581.3	1873.2
	8	0	355.1	1457.7	0	154.3	760.9
	9	1773.7	452.4	641.6	0	1151.9	398.2
	10	0	137.6	859.1	0	516.7	0.0
	11	0	385.7	0	0	691.3	0.0
Total	Biomass	543349.9	12780.2	42003.6	43784.3	57415.4	20376.3

SPRING Spawners NAFO 4Vn	AGE	1990	1991	1992	1993	1994	1995
	0	0	0	0	0	--	--
	1	40.8	0	185.3	58.6	--	--
	2	1103	10	286.5	373.2	--	--
	3	208	7.7	465.1	96.8	--	--
	4	3600.5	0	302.5	56.5	--	--
	5	1313.5	0	0	0	--	--
	6	345.6	26.4	154.8	415.9	--	--
	7	2646.1	0	0	0	--	--
	8	0	0	0	0	--	--
	9	886	0	399.6	0	--	--
	10	676.5	0	0	0	--	--
	11	0	0	0	0	--	--
Total	Biomass	10819.9	44.2	1793.8	1001	--	--

SPRING Spawners NAFO4TVn	AGE	1990	1991	1992	1993	1994	1995
	0	674.7	0	0	0	--	--
	1	184103.9	1254.5	5757.5	1693.9	--	--
	2	324828.8	4894.1	5486.5	26151.4	--	--
	3	25336	2926.2	5718.2	2896	--	--
	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	--	--
	8	0	355.1	1457.7	0	--	--
	9	2659.7	452.4	1041.1	0	--	--
	10	676.5	137.6	859.1	0	--	--
	11	0	385.7	0	0	--	--
Spring	Biomass	554169.8	12824.3	43797.4	44785.3	--	--
Spring proportion		0.59	0.29	0.23	0.34	0.32	0.32

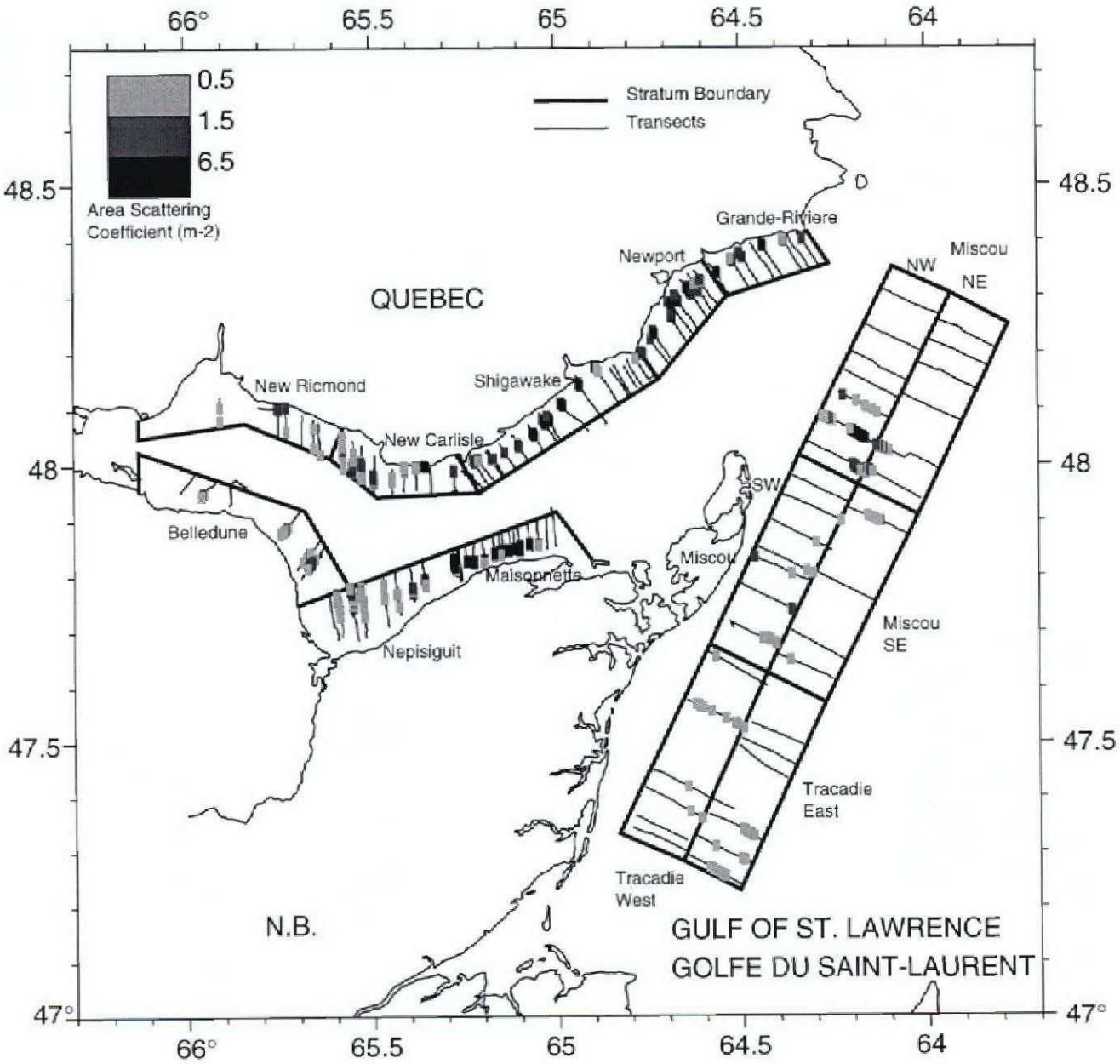

Figure 1. Chaleur-Miscou area 1995 stratum and acoustic transect locations, with relative backscatter detected.

Figure 1. Position des strates et des lignes du releve acousitique 1995, et intensite relative detectee, dans la region Chaleur-Miscou.

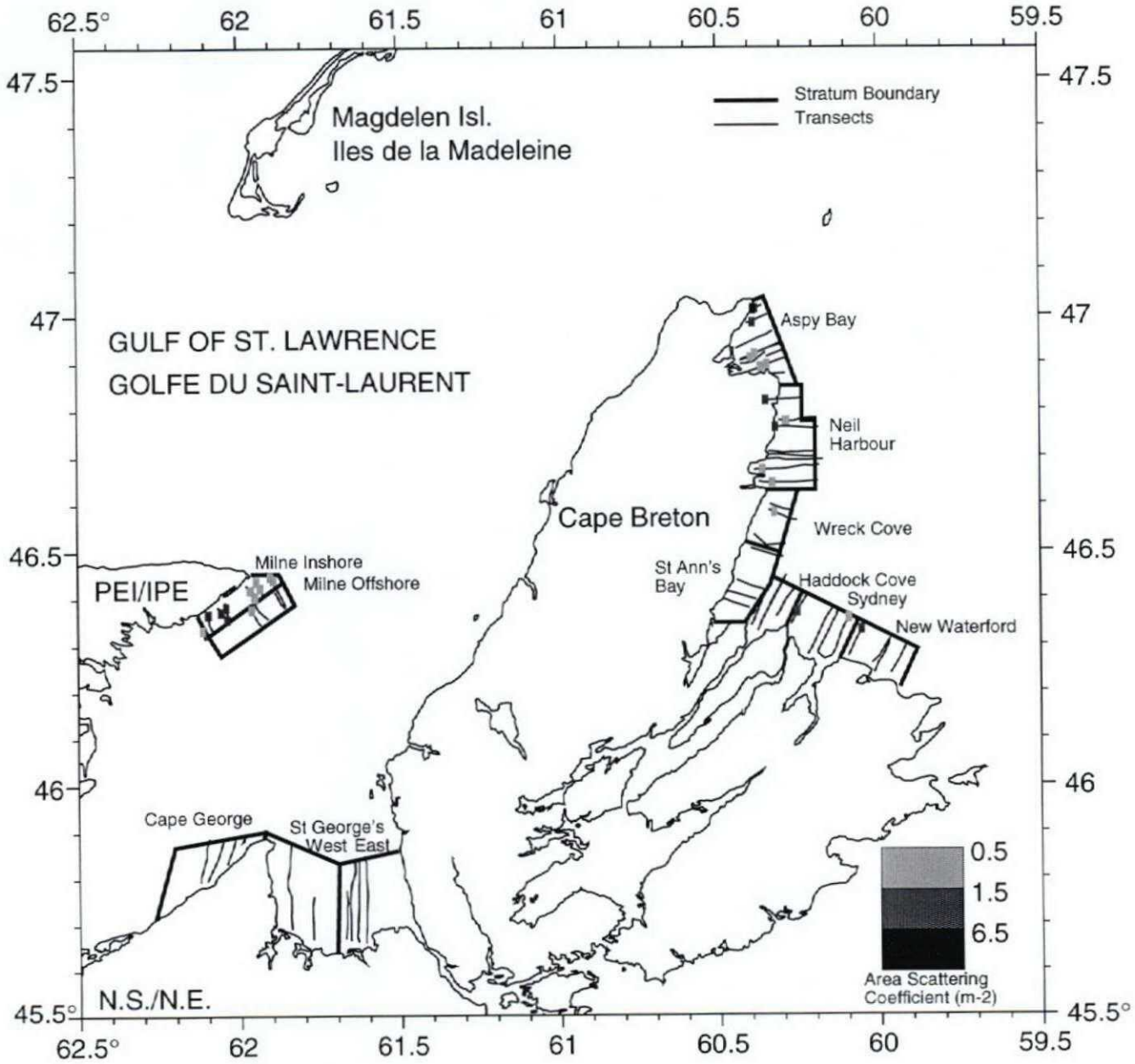

Figure 2. Milne-George's and Cape Breton area stratum and 1995 acoustic transect locations, with relative backscatter detected.

Figure 2. Position des strates et des lignes du releve acoustique 1995, et intensite relative detectee dans les regions Milne-George's et du Cap Breton.

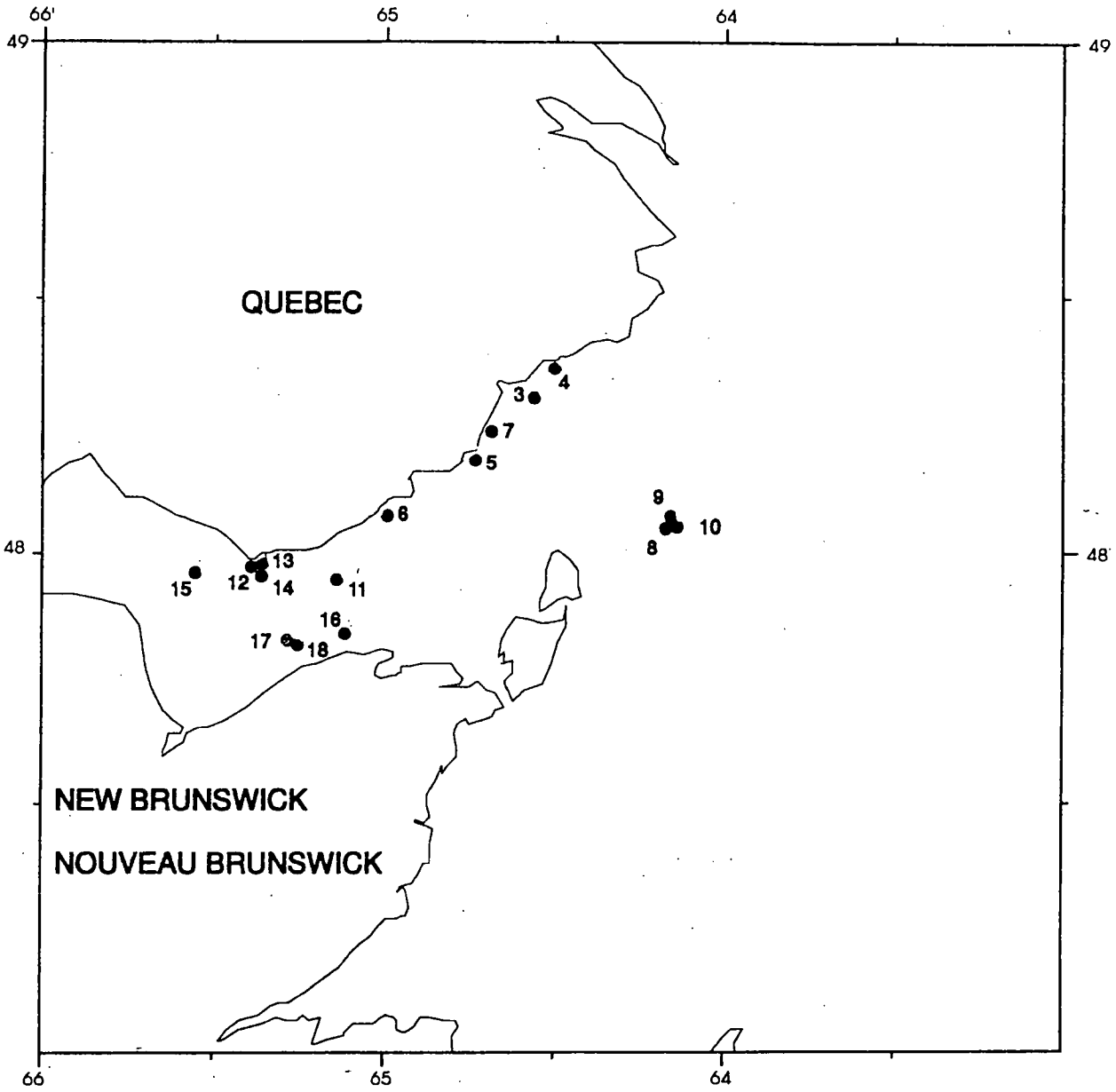

Figure 3. 1995 Herring acoustic survey midwater trawl set locations.
Figure 3. Emplacement des traits de chalut lors du relevé acoustique 1995.

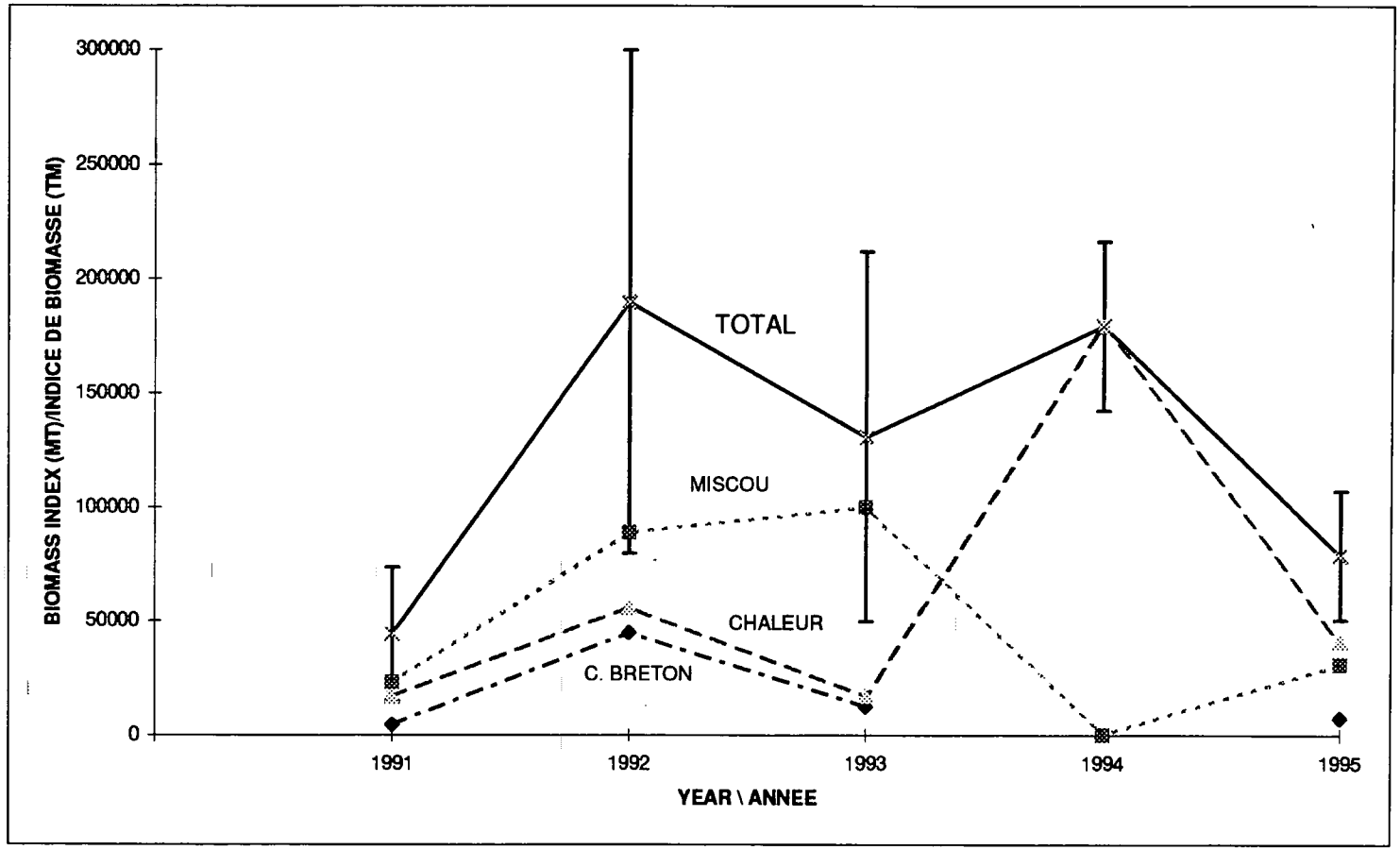

Figure 4. Total and by area biomass estimates, acoustic surveys, 1991 - 1995.

Figure 4. Estimés de biomasse totale et par region, relevés acoustiques, 1991 - 1995.

(Bars are +/- 2 standard errors of TOTAL estimate) (Lignes sont +/- 2 erreurs standards du TOTAL)

* 1995 Total does not include Milne-Georges strata * Le total 1995 n'inclue pas les strates Milne-George's

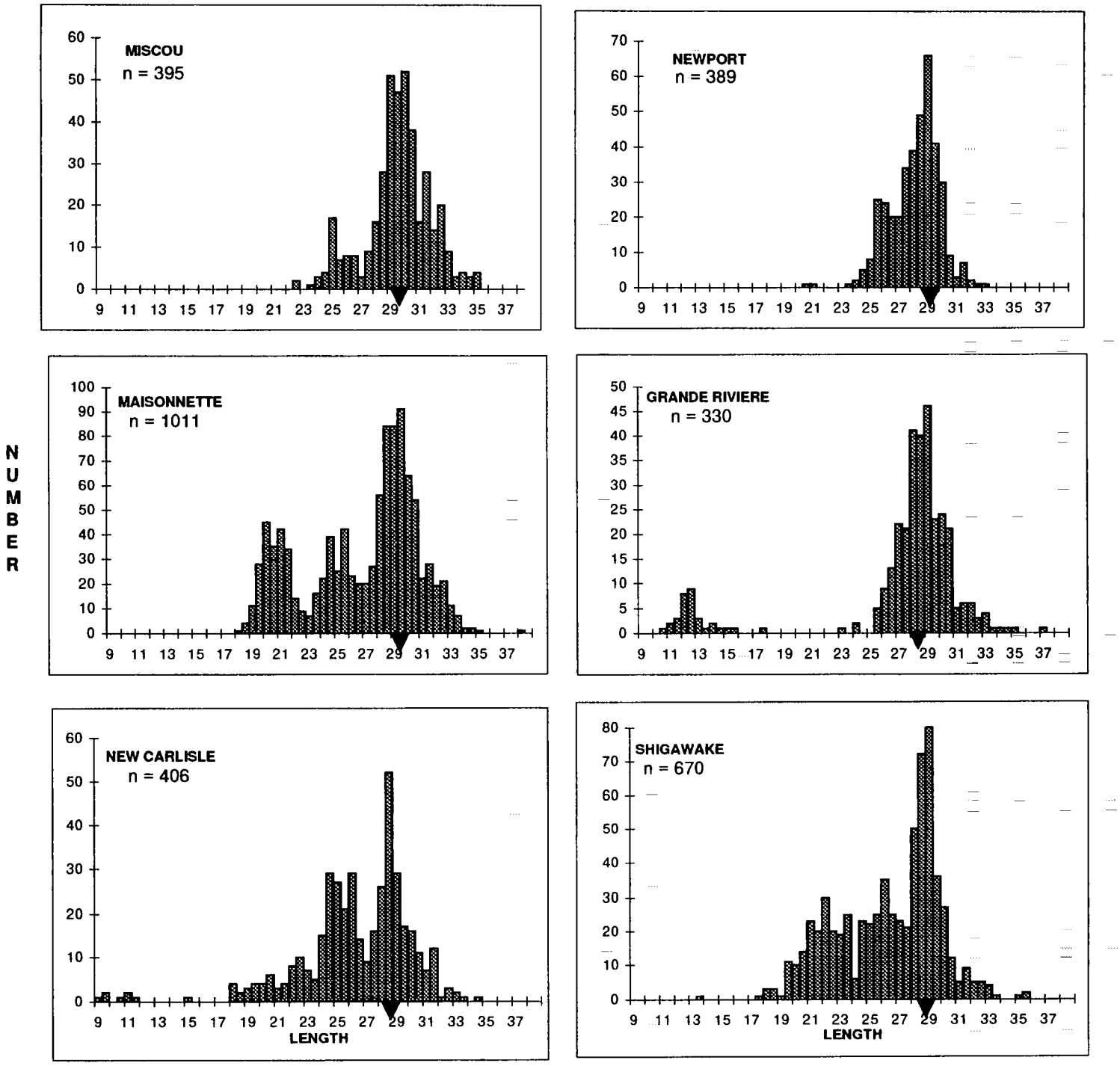

Figure 5. 1995 herring acoustic survey samples length frequency distributions per strata.
Figure 5. Fréquence-longueurs des échantillons de harengs par strates, relevé acoustique 1995.
Inverted triangle indicates modal length. / Triangle inversé indique la longueur modale.

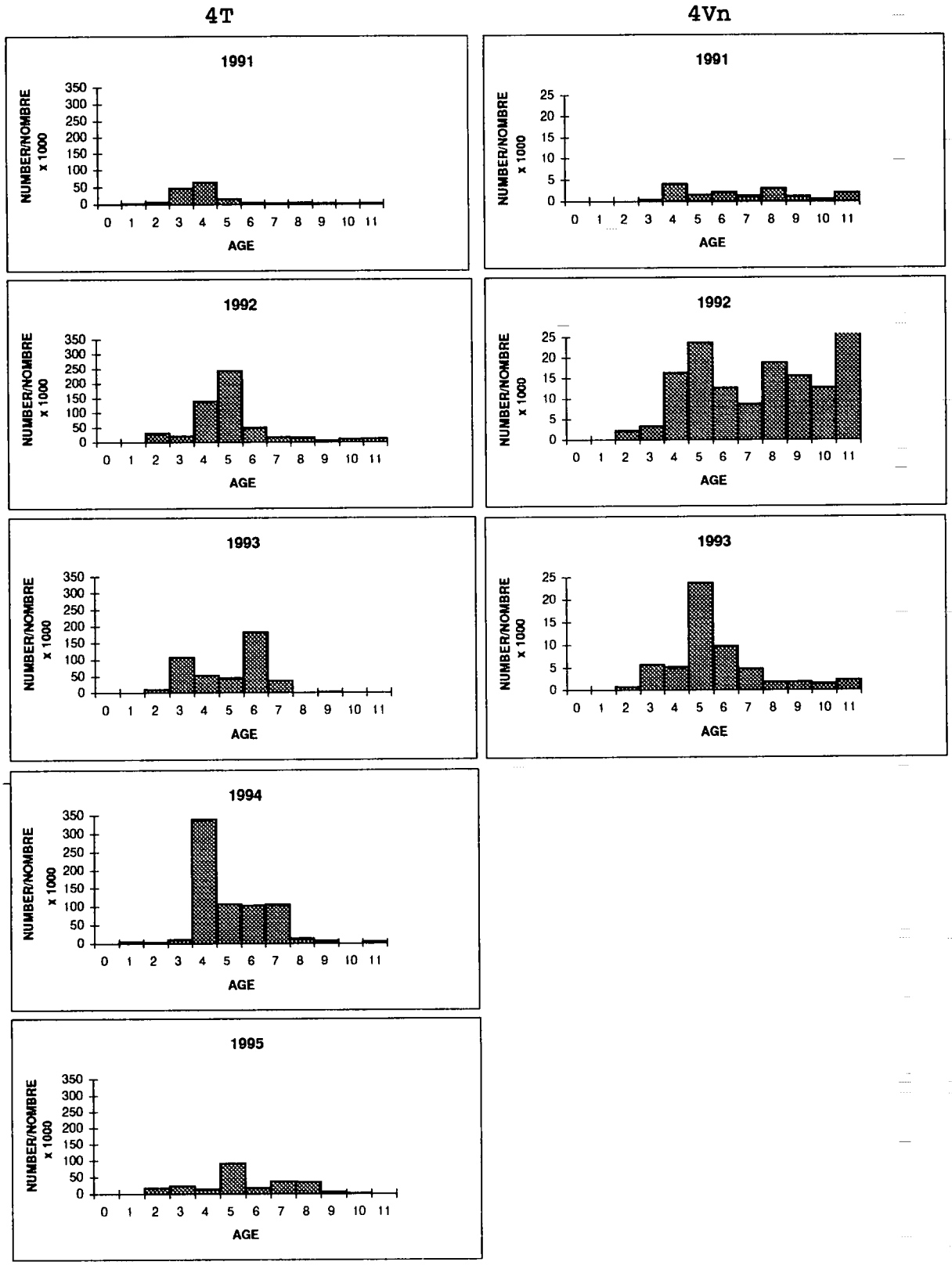

Figure 6. Numbers at age of FALL spawners, by area, in herring acoustic surveys.
Figure 6. Nombres à l'âge des géniteurs d'AUTOMNE par région, relevés acoustiques.

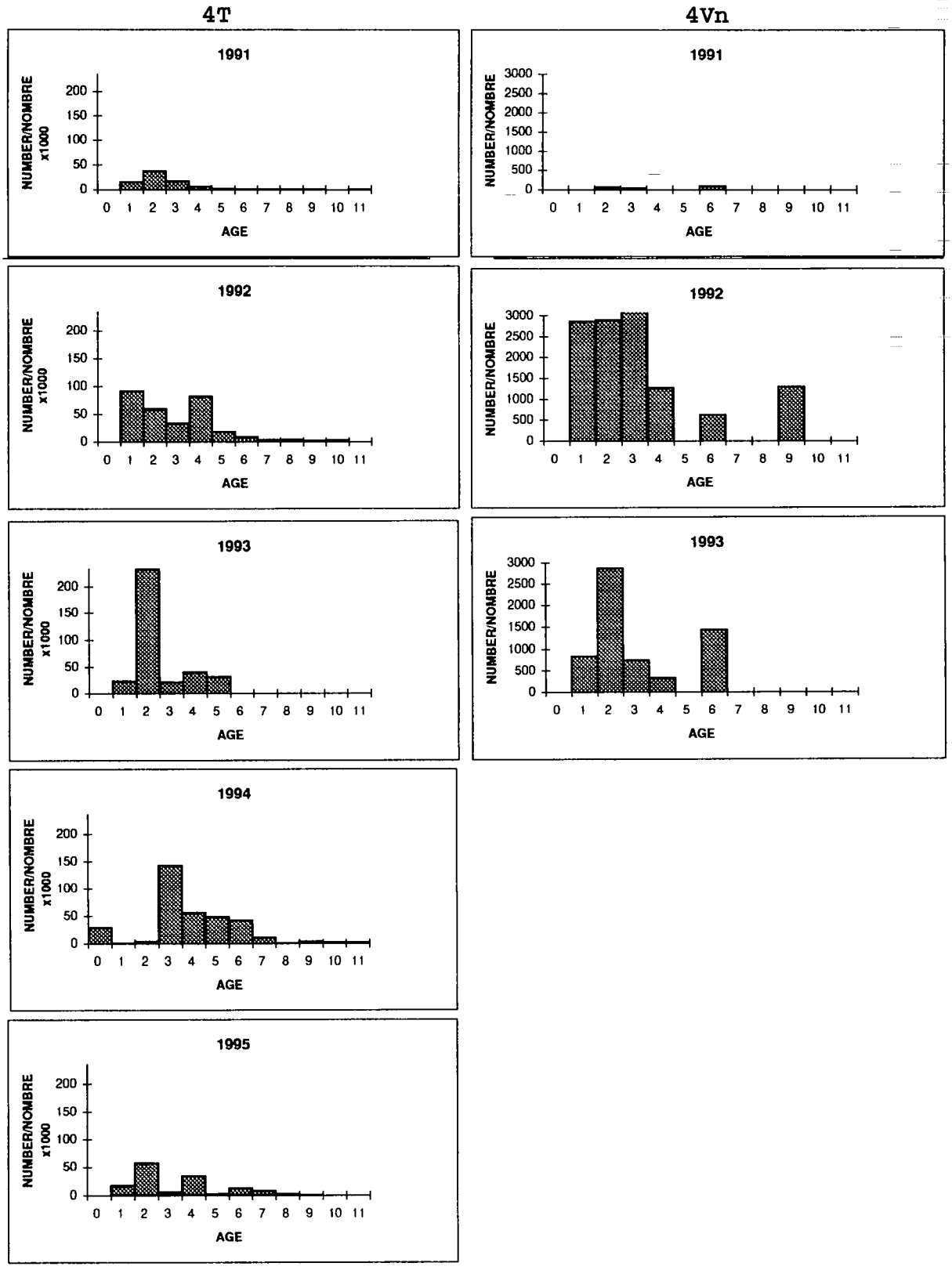

Figure 7. Numbers at age of SPRING spawners, by area, in herring acoustic surveys.
Figure 7. Nombres à l'âge des géniteurs de PRINTEMPS par région, relevés acoustiques.

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

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

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

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

Strata and Area formulas

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

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

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

$$\text{Area Variance} = \sum (\text{SE per stratum})^2$$

$$\text{Area Variance Coefficient (CV)} = \frac{\text{sqare root of Area Variance}}{\text{Area Biomass Estimate}}$$

Appendix 2. Mean lengths and weights, spawning group and target strength of herring from acoustic survey samples.
Annexe 2. Longueurs et poids moyens, groupe géniteur et indice de réflexion acoustique des échantillons receuillis.

Area and Year	Strata	Mean Lenght (cm)	Number sampled	Weight at Mean Length (g)	Length-Weight Relation	Percent of Fall Spawners by Weight	Target Strength (dB/Kg)
CHALEUR-MISCOU							
1995	Miscou,Tracadie	29.6	80	214.3	$0.004978*len^{3.15}$	68*	-35.78
	Newport	26.3	52	179.4	$0.00251*len^{3.351}$	"	-35.46
	Grande-Rivière	27.2	63	156.2	$0.006878*len^{3.037}$	"	-35.15
	Shigawake	26.3	132	135.8	$0.031113*len^{2.563}$	"	-34.83
	New Carlisle-Richmond	26.3	178	144.8	$0.002875*len^{3.312}$	"	-35.11
	Maisonnette,Nepisiquit	26.7	146	155.4	$0.003934*len^{3.222}$	"	-35.28
1994	Belledune	25.4	539	121.5	$0.00390*len^{3.198}$	68*	-34.60
	remaining	28.4	1385	176.2	$0.00233*len^{3.357}$	"	-35.30
1993	Chaleur Bay	28.0	598	166.9	$0.00328*len^{3.252}$	63*	-35.20
	West Miscou	24.8	271	111.4	$0.01760*len^{2.726}$	"	-34.60
MILNE-GEORGES							
1995	all	---	---	---	---	---	-35.3**
CAPE BRETON							
1995	all	---	---	---	---	---	-35.3**
1994	none	---	---	---	---	---	---
1993	all	30.2	960	199.5	$0.00700*len^{3.01}$	92	-35.30

* Percent represents all Chaleur-Miscou samples combined
** No samples taken, yearly mean target strength of all samples combined