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Newfoundland Southeast Coast Herring - 1992 Acoustic Survey Results

by

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Abstract

The results of an acoustic survey of the Fortune Bay and St. Mary's Bay - Placentia Bay herring stock complexes, conducted during the winter of 1992, are presented. A 120 kHz hydroacoustic system was used to calculate integrated density estimates along a series of randomly selected parallel transects within each stock area. A target strength / fish length relationship, calculated from a series of experiments on net enclosed herring in Newfoundland waters, was used to convert acoustic backscatter to biomass. Results of the survey are compared with results of a similar survey conducted in 1990.

Résumé

Le présent document expose les résultats d'un relevé acoustique des zones de stock de hareng des baies de Fortune, St. Mary's et Placentia réalisé au cours de l'hiver 1992. Les estimations de densité intégrées ont été établies à l'aide d'un système hydro-acoustique de 120 kHz le long de bandes parallèles choisies au hasard dans chaque zone de stock. On s'est servi d'un rapport entre l'abondance-cible et la longueur du poisson, calculé dans le cadre d'une série d'expériences sur du hareng pris au filet dans les eaux de Terre-Neuve, pour convertir la rétrodiffusion en biomasse. On compare les résultats du relevé à ceux d'un relevé acoustique effectué en 1990.

Introduction

There are five herring stock complexes within the Newfoundland Region which are assessed by hydroacoustic surveys. The three northern areas (White Bay - Notre Dame Bay, Bonavista Bay - Trinity Bay, and Conception Bay - Southern Shore) are surveyed during the fall. The two southern stock areas (St. Mary's Bay - Placentia Bay and Fortune Bay) are surveyed during the winter when herring are aggregated in overwintering concentrations. Surveys of the three northern and two southern areas are conducted on an alternate fiscal year basis.

This paper documents the results of an acoustic survey of Fortune Bay and St. Mary's Bay - Placentia Bay conducted from January 13, 1992 to March 5, 1992. Prior to this, the last survey of these areas was conducted during the winter of 1990 (Wheeler 1990).

Acoustic Survey Design

The survey commenced at Pass Island, Fortune Bay and terminated at Holyrood, Conception Bay. The R.V. SHAMOOK served as the hydroacoustic platform from which a BioSonics 120 kHz hydroacoustic system was deployed. The SHAMOOK was also equipped with an Engels 400 midwater trawl for biological sampling. The R.V. MARINUS, equipped with a herring purse seine, was also attendant during part of the survey to collect biological samples. The surveys of Fortune Bay and St. Mary's Bay - Placentia Bay were completed. However, due to substantial ice cover in Conception Bay (Appendix 11), the survey of this area could not be completed and a biomass estimate could not be derived for the Conception Bay - Southern Shore stock complex. No herring were detected along transects in the Southern Shore portion of this stock complex.

The acoustic survey design was the same as in the 1990 acoustic survey of these stocks (Wheeler 1990) with the exception of the designation of strata types. In 1990, the strata were divided into two types only (low and high); in 1992, four strata types (headland, low, medium, and high) were designated (Appendices 1-11), based upon distributional patterns observed during the 1990 survey. Sampling intensity (total transect length) was allocated, prior to the survey, on a 1:2:6:11 ratio for low to high density strata.

Biological Sampling

Herring were caught in thirteen sets during the survey (Table 1). Sampling was good in all areas where large concentrations of herring were found except for Bar Haven, Placentia Bay, where only immature herring were sampled. Herring were detected in four strata in Fortune Bay and were sampled in three of those which accounted for 98% of the estimated biomass. In St. Mary's Bay - Placentia Bay, herring were detected in five strata and were sampled in three which accounted for 99% of the estimated biomass.

For those strata where herring were both detected and sampled, samples from the stratum were used to calculate mean fish lengths and weights for the stratum (Table 2). For those strata where herring were detected but not sampled (and for stratum 8 in Placentia Bay where only

immature herring were caught), all samples from the stock area were combined to calculate mean lengths and weights.

In both of the stock areas, spring spawners were dominant (Fig. 1) and percentages were similar to those observed during the 1990 acoustic survey. Immature fish, 1990 year-class in Fortune Bay and 1991 year-class in Placentia Bay, dominated the population estimates by number. The 1987, 1986, 1983, and 1982 year-classes were also evident, similar to that observed during the 1990 survey.

Acoustic Data Analysis

1) Hydroacoustic Calibration for the 1992 Survey

The hydroacoustic system used during the 1992 survey was calibrated by BioSonics Inc. on December 11, 1991 immediately prior to the survey. During the survey, the initial transducer was flooded and was replaced with a leased unit obtained from BioSonics. The leased transducer was calibrated with the hydroacoustic system immediately subsequent to the survey on March 17, 1992. Calibration parameters for the initial and leased configurations were as follows:

	Initial	Leased
Source Level (dB/uPa)	212.93	211.86
Receive Sens. (dBv/uPa)	-147.16	-146.68
Fixed Receiver GAin (dB)	-6	-6
TVG Gain	20logR	20logR
Pulse Length (msec)	0.4	0.4
Beam Pattern Factor	0.00245	0.00347
Sampling Thres. (v) @3-120m	0.05	0.05
@120-150m	0.10	0.10

In addition, the system was calibrated with a standard sphere on numerous occasions during the survey. During each of these calibrations, after soaking the transducer and standard target for approximately two hours, the target strength of the calibration ball stabilized at -40.8 dB, within 0.2 dB of the standard value. To overcome any potential problems caused by "soak time", the transducer was left in the water throughout the entire survey, except when the vessel was berthing and unberthing.

2) Species Identification

The same process described for previous acoustic surveys (Wheeler 1991) was used to identify herring concentrations along transects for inclusion in data analysis. Of the 53 traces detected during the survey, 26% were identified as herring. Of those eliminated from the analysis, most were identified either as cod (31%) or plankton (36%).

3) Target Strength - Fish Length Relationship

The following relationship, derived by measuring the target strengths of different length ranges of herring at 120 kHz within a net enclosure, was used to convert backscatter to biomass in the 1992 survey results:

$$T.S. = 50.28 \log L - 107.9$$

This is the same relationship used for the last survey of these stocks, the derivation of which is described in Wheeler (1991). It should also be noted that the mean lengths of fish sampled during the survey (Table 2) and used to calculate target strength, were within the bounds of the experimental target strength - fish length relationship.

Although two research initiatives were undertaken in 1991 to measure herring target strengths experimentally and in situ, no further results were obtained. An experiment, using the net enclosure, conducted in September 1991 to examine target strength in relation to condition factor and maturation stage was unsuccessful due to an insufficient supply of live and healthy fish. A one week research cruise was also conducted in Bonavista Bay in October 1991 from the R.V. SHAMOOK. The purpose of this cruise was to measure herring target strengths in situ as a comparison with experimental results. Although herring concentrations were detected in several locations and five midwater sets were made, no biological samples were obtained as the fish schools were relatively small in size and were moving faster than the midwater trawl.

In response to the research recommendation that the implications of a target strength - fish length relationship using observed rather than average target strengths be evaluated towards the long-term goal of incorporating target strength variance into acoustic biomass estimates, this has not yet been resolved. There is no direct way of relating observed fish target strength to fish length when the observed target strengths have been derived from a group of fish with a range of lengths. This will be further evaluated in target strength experiments planned for 1992 by attempting to measure target strengths of single fish or fish of the same length.

Acoustic Survey Results

Integrated density estimates were calculated for the 224 transects surveyed within both stock areas. Formulas used to calculate mean densities, variances, and biomass estimates remain unchanged from previous surveys and are given in Wheeler (1991).

Density estimates, by transect and stratum, are presented in Tables 3 and 4 and are summarized by stock area in Table 5. Herring in stratas 9 and 11 in Fortune Bay were detected in the same location in both 1990 and 1992. Similarly, herring in stratas 11 and 12 in Placentia Bay were in the same geographical location in each of the last two surveys.

Mean biomass (t) and population numbers ($\times 10^6$) by stock area from the 1992 acoustic survey are provided in the following text table. Estimates from the 1990 survey are provided for comparison:

	1990			1992		
	Biomass	Pop'n Nos	C.V.	Biomass	Pop'n Nos	C.V.
FB	7730	31.1	0.69	7330	28.0	0.85
SMB-PB	18013	60.5	0.88	8665	46.4	0.46

Both the biomass and population numbers estimate for Fortune Bay were very similar from both the 1990 and 1992 acoustic surveys. Although the 1992 biomass estimate for St. Mary's Bay - Placentia Bay was reduced by approximately 50%, population numbers (Table 6) decreased by approximately 25%.

Acknowledgements

Thanks are extended to the Pelagic Section personnel who participated in the acoustic survey, in particular Ray Chaulk who drafted the acoustic transects. Thank you also the the crews of the R.V. SHAMOOK and R.V. MARINUS for their assistance in conducting a successful acoustic survey.

References Cited

- Wheeler, J. P. 1990. Newfoundland southeast coast herring - 1990 acoustic survey results. CAFSAC Res. Doc. 90/55. 50 p.
1991. Newfoundland east coast herring - 1990 acoustic survey results. CAFSAC Res. Doc. 91/1. 43 p.

Table 1. SHAMOOK midwater trawl and MARINUS purse seine set details for the 1992 herring acoustic survey, Fortune Bay, St. Mary's Bay-Placentia Bay, and Conception Bay-Southern Shore.

Set no.	Date	Time	Location	Surface temp.	Bottom temp.	Results
S1	Jan. 13	1605	Little Hr., Fortune Bay	-	-	No catch
S2	Jan. 13	1635	Little Hr., Fortune Bay	-	-	No catch
S3	Jan. 13	1800	Little Hr., Fortune Bay	1.9	1.1	Caught 14 herring (30-39 cm)
S4	Jan. 15	1235	Northeast Arm, Fortune Bay	-	-	No catch
S5	Jan. 15	1325	Northeast Arm, Fortune Bay	-	-	No catch
S6	Jan. 15	1415	Northeast Arm, Fortune Bay	1.2	1.8	No catch
S7	Jan. 15	1550	Northeast Arm, Fortune Bay	-	-	No catch
S8	Jan. 15	1725	Northeast Arm, Fortune Bay	-	-	Caught 53 herring (29-40 cm) and 2 redfish
S9	Jan. 15	1830	Northeast Arm, Fortune Bay	-	-	Caught 20 herring (30-39 cm) and 1 redfish
S10	Jan. 16	1725	Northeast Arm, Fortune Bay	-	-	Caught 61 herring (30-38 cm)
S11	Jan. 20	1435	Bay L'Argent, Fortune Bay	0.4	1.6	No catch
S12	Jan. 20	1505	Bay L'Argent, Fortune Bay	-	-	No catch
S13	Jan. 21	1450	Long Hr., Fortune Bay	-	-	No catch
S14	Jan. 21	1735	Long Hr., Fortune Bay	1.5	2.1	Caught 19 herring (12-31 cm) and 1 cod
S15	Jan. 21	1820	Long Hr., Fortune Bay	-	-	Caught 75 kg herring (19-35 cm)
S16	Jan. 21	1900	Long Hr., Fortune Bay	-	-	Caught 46 herring (20-27 cm)
M1	Jan. 22	1615	Bay L'Argent, Fortune Bay	-	-	No catch
M2	Jan. 23	1205	Bay L'Argent, Fortune Bay	-	-	No catch
M3	Jan. 23	1515	Little Bay, Fortune Bay	0.1	1.8	Caught ~45,000 kg herring (9-23 cm)
S17	Jan. 23	1835	Bay L'Argent, Fortune Bay	0.5	-0.3	Caught 450 kg herring (20-40 cm)
M4	Jan. 28	1445	Big Conne, Fortune Bay	0.6	1.3	No catch
M5	Feb. 10	1055	Harbour Buffett, Placentia Bay	1.1	0.2	No catch
S18	Feb. 11	1540	Bar Haven Is., Placentia Bay	-0.6	0.4	Caught 1350 kg cod (37-106 cm) and greysole, flounder and haddock
M6	Feb. 17	1700	Bar Haven Is., Placentia Bay	-0.7	-0.3	Caught 35 herring (14-16 cm)
S19	Feb. 18	1425	Burnt Head, Placentia Bay	-	-	No catch
S20	Feb. 18	1500	Burnt Head, Placentia Bay	-	-	Caught 3 herring (23-32 cm)
S21	Feb. 18	1615	Burnt Head, Placentia Bay	-	-	No catch
S22	Feb. 18	1810	Burnt Head, Placentia Bay	-0.9	-0.8	Caught 55 herring (17-38 cm)
S23	Feb. 18	1900	Burnt Head, Placentia Bay	-	-	Caught 65 kg herring (15-39 cm)
S24	Feb. 24	1435	Western Head, Conception Bay	-1.6	-1.5	Caught capelin (35-55 mm) and euphausiids

Table 2. Biological samples used to calculate mean lengths, mean weights and population numbers at age from the 1992 herring acoustic survey, Fortune Bay and St. Mary's Bay-Placentia Bay.

Stock area	Survey strata	Survey dates	Sampling location	Sample strata	Sample dates	Sampling gear	# fish sampled	Mean lgt. (cm)	Mean wgt. (gm)
FB	2	Jan. 14-15	Northeast Arm	2	Jan. 15-16	Res. MWT	149	35.3	353.3
	6	Jan. 17	Northeast Arm	2	Jan. 15-16	Res. MWT	149	35.3	353.3
			Long Harbour	9	Jan. 21	Res. MWT	155	21.6	76.4
			Bay L'Argent	11	Jan. 23	Res. MWT	100	31.6	238.1
	9	Jan. 19	Long Harbour	9	Jan. 21	Res. MWT	155	21.6	76.4
11	Jan. 28-29	Bay L'Argent	11	Jan. 23	Res. MWT	100	31.6	238.1	
SMB-PB	5,8	Feb. 2-4	Bar Haven	8	Feb. 17	Res. PS	33	15.0	22.0
			Harbour Buffett	12	Feb. 10	Comm. PS	100	33.4	297.5
			Fairhaven	11	Feb. 18	Res. MWT	150	33.6	293.9
	11	Feb. 18-19	Fairhaven	11	Feb. 18	Res. MWT	150	33.6	293.9
	12	Feb. 9-10	Harbour Buffett	12	Feb. 10	Comm. PS	100	33.4	297.5
	18	Feb. 19-20	Bar Haven	8	Feb. 17	Res. PS	33	15.0	22.0
			Harbour Buffett	12	Feb. 10	Comm. PS	100	33.4	297.5
Fairhaven			11	Feb. 18	Res. MWT	150	33.6	293.9	

Table 3. Biomass and backscatter estimates, for Portune Bay, from the 1992 acoustic survey.

STOCK AREA	STRATUM	TARGET STRENGTH (dB/kg)	TRANSECT NUMBER	TRANSECT LENGTH (n.mi.)	TRANSECT AREA (m ²)	TRANSECT BIOMASS (t)	WEIGHTED DENSITY (kg/m ²)	TRANSECT TOTAL SCATTER (m ² /sr)	WEIGHTED SCATT. COEFF. (/sr)	SET NUMBER	NUMBER OF FISH SAMPLED	
PB	1	-27.60	1	0.83	1.423E+06	0	0.00000	0	0.000E+00			
			2	3.18	5.454E+06	0	0.00000	0	0.000E+00			
			3	5.62	9.638E+06	0	0.00000	0	0.000E+00			
				3		5.505E+06 1.651E+07		0.00000		0.000E+00		
		2	-25.55	4	1.00	1.715E+06	0	0.00000	0	0.000E+00		
	5			1.40	2.401E+06	0	0.00000	0	0.000E+00			
	6			2.04	3.499E+06	0	0.00000	0	0.000E+00			
	7			0.88	1.509E+06	0	0.00000	0	0.000E+00			
	8			0.33	5.659E+05	0	0.00000	0	0.000E+00			
	9			1.18	2.024E+06	1127	0.59820	3138	1.665E-03	S8-10	149	
	10			0.86	1.475E+06	0	0.00000	0	0.000E+00			
				7		1.884E+06 1.319E+07		0.08546		2.379E-04		
		3	-27.60	11	1.41	2.418E+06	0	0.00000	0	0.000E+00		
	12			2.04	3.499E+06	0	0.00000	0	0.000E+00			
	13			2.37	4.064E+06	0	0.00000	0	0.000E+00			
				3		3.327E+06 9.981E+06		0.00000		0.000E+00		
		5	-27.60	14	0.82	1.406E+06	0	0.00000	0	0.000E+00		
	15			1.91	3.276E+06	0	0.00000	0	0.000E+00			
	16			1.68	2.881E+06	0	0.00000	0	0.000E+00			
	17			0.90	1.543E+06	0	0.00000	0	0.000E+00			
				4		2.277E+06 9.106E+06		0.00000		0.000E+00		
	6	-27.60	18	2.12	3.636E+06	0	0.00000	0	0.000E+00			
19			2.03	3.481E+06	0	0.00000	0	0.000E+00				
20			2.43	4.167E+06	0	0.00000	0	0.000E+00				
21			1.45	2.487E+06	0	0.00000	0	0.000E+00				
22			0.64	1.098E+06	0	0.00000	0	0.000E+00				
23			2.97	5.093E+06	0	0.00000	0	0.000E+00				
24			2.80	4.802E+06	0	0.00000	0	0.000E+00				
25			1.06	1.818E+06	48	0.01413	84	2.456E-05				
34			2.48	4.253E+06	0	0.00000	0	0.000E+00				
					9		3.426E+06 3.083E+07		0.00157		2.729E-06	

Table 3 (cont.). Biomass and backscatter estimates, for Fortune Bay, from the 1992 acoustic survey.

STOCK AREA	STRATUM	TARGET STRENGTH (dB/kg)	TRANSECT NUMBER	TRANSECT LENGTH (n.mi.)	TRANSECT AREA (m ²)	TRANSECT BIOMASS (t)	WEIGHTED DENSITY (kg/m ²)	TRANSECT TOTAL SCATTER (m ² /sr)	WEIGHTED SCATT. COEFF. (/sr)	SET NUMBER	NUMBER OF FISH SAMPLED
	7	-27.60	26	0.18	3.087E+05	0	0.00000	0	0.000E+00		
			27	0.41	7.031E+05	0	0.00000	0	0.000E+00		
			28	1.25	2.144E+06	0	0.00000	0	0.000E+00		
			29	0.14	2.401E+05	0	0.00000	0	0.000E+00		
			30	0.11	1.886E+05	0	0.00000	0	0.000E+00		
			31	1.48	2.538E+06	0	0.00000	0	0.000E+00		
			32	1.26	2.161E+06	0	0.00000	0	0.000E+00		
			33	0.83	1.423E+06	0	0.00000	0	0.000E+00		
			8		1.213E+06 9.707E+06		0.00000		0.000E+00		
	8	-27.60	35	0.08	1.372E+05	0	0.00000	0	0.000E+00		
			36	0.26	4.459E+05	0	0.00000	0	0.000E+00		
			37	0.41	7.031E+05	0	0.00000	0	0.000E+00		
			38	0.42	7.203E+05	0	0.00000	0	0.000E+00		
			39	0.20	3.430E+05	0	0.00000	0	0.000E+00		
			40	0.92	1.578E+06	0	0.00000	0	0.000E+00		
			41	0.26	4.459E+05	0	0.00000	0	0.000E+00		
			42	0.26	4.459E+05	0	0.00000	0	0.000E+00		
			43	0.50	8.575E+05	0	0.00000	0	0.000E+00		
			44	1.04	1.784E+06	0	0.00000	0	0.000E+00		
			45	0.58	9.947E+05	0	0.00000	0	0.000E+00		
			46	0.53	9.089E+05	0	0.00000	0	0.000E+00		
			47	0.30	5.145E+05	0	0.00000	0	0.000E+00		
			48	0.90	1.543E+06	0	0.00000	0	0.000E+00		
			49	0.85	1.458E+06	0	0.00000	0	0.000E+00		
			50	0.53	9.089E+05	0	0.00000	0	0.000E+00		
			51	0.56	9.604E+05	0	0.00000	0	0.000E+00		
			17		8.676E+05 1.475E+07		0.00000		0.000E+00		
	9	-29.63	52	1.20	2.058E+06	0	0.00000	0	0.000E+00		
			53	1.30	2.229E+06	0	0.00000	0	0.000E+00		
			54	1.05	1.801E+06	0	0.00000	0	0.000E+00		
			55	0.58	9.947E+05	0	0.00000	0	0.000E+00		
			56	0.92	1.578E+06	0	0.00000	0	0.000E+00		
			57	0.67	1.149E+06	14	0.00859	15	9.357E-06		
			58	0.98	1.681E+06	235	0.14317	256	1.559E-04	S14-16	165
			7		1.641E+06 1.149E+07		0.02168		2.361E-05		

Table 3 (cont.). Biomass and backscatter estimates, for Fortune Bay, from the 1992 acoustic survey

STOCK AREA	STRATUM	TARGET STRENGTH (dB/kg)	TRANSECT NUMBER	TRANSECT LENGTH (n.mi.)	TRANSECT AREA (m ²)	TRANSECT BIOMASS (t)	WEIGHTED DENSITY (kg/m ²)	TRANSECT TOTAL SCATTER (m ² /sr)	WEIGHTED SCATT. COEFF. (/sr)	SET NUMBER	NUMBER OF FISH SAMPLED
	10	-27.60	59	0.63	1.080E+06	0	0.00000	0	0.000E+00		
			60	0.50	8.575E+05	0	0.00000	0	0.000E+00		
			61	0.58	9.947E+05	0	0.00000	0	0.000E+00		
			62	0.60	1.029E+06	0	0.00000	0	0.000E+00		
			63	0.18	3.087E+05	0	0.00000	0	0.000E+00		
			64	0.22	3.773E+05	0	0.00000	0	0.000E+00		
			65	0.43	7.374E+05	0	0.00000	0	0.000E+00		
			66	0.21	3.601E+05	0	0.00000	0	0.000E+00		
			67	0.60	1.029E+06	0	0.00000	0	0.000E+00		
			68	0.35	6.002E+05	0	0.00000	0	0.000E+00		
			69	0.27	4.630E+05	0	0.00000	0	0.000E+00		
			70	0.47	8.060E+05	0	0.00000	0	0.000E+00		
			71	0.50	8.575E+05	0	0.00000	0	0.000E+00		
			72	0.50	8.575E+05	0	0.00000	0	0.000E+00		
			73	0.20	3.430E+05	0	0.00000	0	0.000E+00		
			74	0.23	3.944E+05	0	0.00000	0	0.000E+00		
			75	0.58	9.947E+05	0	0.00000	0	0.000E+00		
			76	0.04	6.860E+04	0	0.00000	0	0.000E+00		
			77	0.23	3.944E+05	0	0.00000	0	0.000E+00		
			78	0.18	3.087E+05	0	0.00000	0	0.000E+00		
			79	0.43	7.374E+05	0	0.00000	0	0.000E+00		
			21		6.476E+05 1.360E+07		0.00000		0.000E+00		
	11	-26.25	80	0.28	4.802E+05	0	0.00000	0	0.000E+00		
			81	0.47	8.060E+05	0	0.00000	0	0.000E+00		
			82	0.38	6.517E+05	0	0.00000	0	0.000E+00		
			83	0.40	6.860E+05	0	0.00000	0	0.000E+00		
			84	0.11	1.886E+05	0	0.00000	0	0.000E+00		
			85	0.10	1.715E+05	0	0.00000	0	0.000E+00		
			86	0.18	3.087E+05	0	0.00000	0	0.000E+00		
			87	0.11	1.886E+05	0	0.00000	0	0.000E+00		
			88	0.21	3.601E+05	0	0.00000	0	0.000E+00		
			89	0.48	8.232E+05	0	0.00000	0	0.000E+00		
			90	1.80	3.087E+06	0	0.00000	0	0.000E+00		
			91	1.70	2.915E+06	198	0.18306	470	4.340E-04	S17	100
			92	0.97	1.664E+06	0	0.00000	0	0.000E+00		
			93	1.22	2.092E+06	0	0.00000	0	0.000E+00		
			94	1.24	2.127E+06	0	0.00000	0	0.000E+00		
			95	1.00	1.715E+06	0	0.00000	0	0.000E+00		
			96	0.38	6.517E+05	0	0.00000	0	0.000E+00		
			97	0.34	5.831E+05	0	0.00000	0	0.000E+00		
			18		1.083E+06 1.950E+07		0.01017		2.411E-05		

Table 3 (cont.). Biomass and backscatter estimates, for Fortune Bay, from the 1992 acoustic survey.

STOCK AREA	STRATUM	TARGET STRENGTH (dB/kg)	TRANSECT NUMBER	TRANSECT LENGTH (n.mi.)	TRANSECT AREA (m ²)	TRANSECT BIOMASS (t)	WEIGHTED DENSITY (kg/m ²)	TRANSECT TOTAL SCATTER (m ² /sr)	WEIGHTED SCATT. COEFF. (/sr)	SET NUMBER	NUMBER OF FISH SAMPLED
	12	-27.60	98	0.87	1.492E+06	0	0.00000	0	0.000E+00		
			99	0.64	1.098E+06	0	0.00000	0	0.000E+00		
			100	0.58	9.947E+05	0	0.00000	0	0.000E+00		
			3		1.195E+06 3.584E+06		0.00000		0.000E+00		
	13	-27.60	101	2.19	3.756E+06	0	0.00000	0	0.000E+00		
			102	2.23	3.824E+06	0	0.00000	0	0.000E+00		
			103	1.37	2.349E+06	0	0.00000	0	0.000E+00		
			104	1.74	2.984E+06	0	0.00000	0	0.000E+00		
			105	2.83	4.853E+06	0	0.00000	0	0.000E+00		
			5		3.553E+06 1.777E+07		0.00000		0.000E+00		
	14	-27.60	106	1.53	2.624E+06	0	0.00000	0	0.000E+00		
			107	1.13	1.938E+06	0	0.00000	0	0.000E+00		
			2		2.281E+06 4.562E+06		0.00000		0.000E+00		

101.80

Table 4. Biomass and backscatter estimates, for St. Mary's Bay - Placentia Bay, from the 1992 acoustic survey.

STOCK AREA	STRATUM	TARGET STRENGTH (dB/kg)	TRANSECT NUMBER	TRANSECT LENGTH (n.mi.)	TRANSECT AREA (m ²)	TRANSECT BIOMASS (t)	WEIGHTED DENSITY (kg/m ²)	TRANSECT TOTAL SCATTER (m ² /sr)	WEIGHTED SCATT. COEFF. (/sr)	SET NUMBER	NUMBER OF FISH SAMPLED		
SMB-PB	1B	-26.88	108	4.72	8.095E+06	0	0.00000	0	0.000E+00				
			109	4.90	8.403E+06	0	0.00000	0	0.000E+00				
			2		8.249E+06 1.650E+07		0.00000		0.000E+00				
			2	-26.88	110	5.08	8.712E+06	0	0.00000	0	0.000E+00		
			111		4.58	7.854E+06	0	0.00000	0	0.000E+00			
			112		4.14	7.100E+06	0	0.00000	0	0.000E+00			
	113	4.99	8.558E+06		0	0.00000	0	0.000E+00					
	4		8.056E+06 3.222E+07			0.00000		0.000E+00					
	3	-26.88	114	6.16	1.056E+07	0	0.00000	0	0.000E+00				
	1			1.056E+07 1.056E+07		0.00000		0.000E+00					
	4	-26.88	115	5.34	9.158E+06	0	0.00000	0	0.000E+00				
	116		0.10	1.715E+05	0	0.00000	0	0.000E+00					
	121		3.65	6.260E+06	0	0.00000	0	0.000E+00					
	122		4.79	8.215E+06	0	0.00000	0	0.000E+00					
	4			5.951E+06 2.380E+07		0.00000		0.000E+00					
	5	-26.88	117	0.98	1.681E+06	4	0.00245	8	5.015E-06				
	118		1.03	1.766E+06	0	0.00000	0	0.000E+00					
	119		0.83	1.423E+06	0	0.00000	0	0.000E+00					
	120		0.88	1.509E+06	0	0.00000	0	0.000E+00					
	4			1.595E+06 6.380E+06		0.00061		1.254E-06					
6	-26.88	123	0.94	1.612E+06	0	0.00000	0	0.000E+00					
124		0.92	1.578E+06	0	0.00000	0	0.000E+00						
2			1.595E+06 3.190E+06		0.00000		0.000E+00						

Table 4 (cont.). Biomass and backscatter estimates, for St. Mary's Bay - Placentia Bay, from the 1992 acoustic survey.

STOCK AREA	STRATUM	TARGET STRENGTH (dB/kg)	TRANSECT NUMBER	TRANSECT LENGTH (n.mi.)	TRANSECT AREA (m ²)	TRANSECT BIOMASS (t)	WEIGHTED DENSITY (kg/m ²)	TRANSECT TOTAL SCATTER (m ² /sr)	WEIGHTED SCATT. COEFF. (/sr)	SET NUMBER	NUMBER OF FISH SAMPLED
	7	-26.88	126	1.80	3.087E+06	0	0.00000	0	0.000E+00		
			127	2.53	4.339E+06	0	0.00000	0	0.000E+00		
			2		3.713E+06 7.426E+06		0.00000		0.000E+00		
	8	-30.24	131	0.99	1.698E+06	0	0.00000	0	0.000E+00		
			134	0.26	4.459E+05	0	0.00000	0	0.000E+00		
			135	1.76	3.018E+06	414	0.15396	391	1.456E-04		
			136	2.14	3.670E+06	402	0.14935	380	1.412E-04	N6	33
			137	2.69	4.613E+06	0	0.00000	0	0.000E+00		
			5		2.689E+06 1.345E+07		0.06066		5.736E-05		
	9	-26.88	138	3.04	5.213E+06	0	0.00000	0	0.000E+00		
			139	4.33	7.426E+06	0	0.00000	0	0.000E+00		
			140	2.14	3.670E+06	0	0.00000	0	0.000E+00		
			141	4.08	6.997E+06	0	0.00000	0	0.000E+00		
			142	3.63	6.225E+06	0	0.00000	0	0.000E+00		
			143	0.82	1.406E+06	0	0.00000	0	0.000E+00		
			144	0.58	9.947E+05	0	0.00000	0	0.000E+00		
			7		4.562E+06 3.193E+07		0.00000		0.000E+00		
	10	-26.88	145	1.78	3.053E+06	0	0.00000	0	0.000E+00		
			146	0.97	1.664E+06	0	0.00000	0	0.000E+00		
			147	1.70	2.915E+06	0	0.00000	0	0.000E+00		
			178	2.92	5.008E+06	0	0.00000	0	0.000E+00		
			4		3.160E+06 1.264E+07		0.00000		0.000E+00		
	11	-25.87	179	1.03	1.766E+06	0	0.00000	0	0.000E+00		
			180	1.56	2.675E+06	0	0.00000	0	0.000E+00		
			181	3.03	5.196E+06	0	0.00000	0	0.000E+00		
			182	2.83	4.853E+06	0	0.00000	0	0.000E+00		
			183	1.88	3.224E+06	0	0.00000	0	0.000E+00		
			184	1.93	3.310E+06	717	0.20475	1857	5.303E-04	S22&23	150
			188	2.08	3.567E+06	0	0.00000	0	0.000E+00		
			189	1.69	2.898E+06	0	0.00000	0	0.000E+00		
			190	2.35	4.030E+06	0	0.00000	0	0.000E+00		
			9		3.502E+06 3.152E+07		0.02275		5.892E-05		

Table 4 (cont.). Biomass and backscatter estimates, for St. Mary's Bay - Placentia Bay, from the 1992 acoustic survey.

STOCK AREA	STRATUM	TARGET STRENGTH (dB/kg)	TRANSECT NUMBER	TRANSECT LENGTH (n.mi.)	TRANSECT AREA (m ²)	TRANSECT BIOMASS (t)	WEIGHTED DENSITY (kg/m ²)	TRANSECT TOTAL SCATTER (m ² /sr)	WEIGHTED SCATT. COEFF. (/sr)	SET NUMBER	NUMBER OF FISH SAMPLED
	12	-26.01	157	0.17	2.915E+05	0	0.00000	0	0.000E+00		
			158	0.30	5.145E+05	0	0.00000	0	0.000E+00		
			159	0.20	3.430E+05	0	0.00000	0	0.000E+00		
			160	0.30	5.145E+05	0	0.00000	0	0.000E+00		
			161	0.47	8.060E+05	0	0.00000	0	0.000E+00		
			162	0.59	1.012E+06	0	0.00000	0	0.000E+00		
			163	0.35	6.002E+05	0	0.00000	0	0.000E+00		
			164	0.15	2.572E+05	0	0.00000	0	0.000E+00		
			165	1.03	1.766E+06	0	0.00000	0	0.000E+00		
			166	0.44	7.546E+05	0	0.00000	0	0.000E+00		
			167	1.08	1.852E+06	0	0.00000	0	0.000E+00		
			168	0.28	4.802E+05	0	0.00000	0	0.000E+00		
			169	0.89	1.526E+06	0	0.00000	0	0.000E+00		
			170	1.05	1.801E+06	0	0.00000	0	0.000E+00		
			171	0.58	9.947E+05	0	0.00000	0	0.000E+00		
			172	0.91	1.561E+06	0	0.00000	0	0.000E+00		
			173	0.63	1.080E+06	0	0.00000	0	0.000E+00		
			174	0.75	1.286E+06	0	0.00000	0	0.000E+00		
			175	1.45	2.487E+06	0	0.00000	0	0.000E+00		
			177	0.98	1.681E+06	300	0.27776	752	6.963E-04	(COMM.)	100
			20		1.080E+06 2.161E+07		0.01389		3.482E-05		
	13	-26.88	148	1.63	2.795E+06	0	0.00000	0	0.000E+00		
			149	1.51	2.590E+06	0	0.00000	0	0.000E+00		
			150	1.57	2.692E+06	0	0.00000	0	0.000E+00		
			151	1.17	2.006E+06	0	0.00000	0	0.000E+00		
			152	0.91	1.561E+06	0	0.00000	0	0.000E+00		
			153	0.41	7.031E+05	0	0.00000	0	0.000E+00		
			154	0.94	1.612E+06	0	0.00000	0	0.000E+00		
			155	1.77	3.035E+06	0	0.00000	0	0.000E+00		
			156	3.19	5.471E+06	0	0.00000	0	0.000E+00		
			9		2.496E+06 2.247E+07		0.00000		0.000E+00		
	14	-26.88	130	1.72	2.950E+06	0	0.00000	0	0.000E+00		
			132	2.33	3.996E+06	0	0.00000	0	0.000E+00		
			133	0.90	1.543E+06	0	0.00000	0	0.000E+00		
			3		2.830E+06 8.489E+06		0.00000		0.000E+00		

Table 4 (cont.). Biomass and backscatter estimates, for St. Mary's Bay - Placentia Bay, from the 1992 acoustic survey.

STOCK AREA	STRATUM	TARGET STRENGTH (dB/kg)	TRANSECT NUMBER	TRANSECT LENGTH (n.mi.)	TRANSECT AREA (m ²)	TRANSECT BIOMASS (t)	WEIGHTED DENSITY (kg/m ²)	TRANSECT TOTAL SCATTER (m ² /sr)	WEIGHTED SCATT. COEFF. (/sr)	SET NUMBER	NUMBER OF FISH SAMPLED
	15	-26.88	125	0.13	2.229E+05	0	0.00000	0	0.000E+00		
			128	2.53	4.339E+06	0	0.00000	0	0.000E+00		
			129	1.92	3.293E+06	0	0.00000	0	0.000E+00		
			3		2.618E+06 7.854E+06		0.00000		0.000E+00		
	16	-26.88	199	2.48	4.253E+06	0	0.00000	0	0.000E+00		
			200	1.73	2.967E+06	0	0.00000	0	0.000E+00		
			201	1.42	2.435E+06	0	0.00000	0	0.000E+00		
			3		3.218E+06 9.655E+06		0.00000		0.000E+00		
	17	-26.88	176	3.41	5.848E+06	0	0.00000	0	0.000E+00		
			196	2.61	4.476E+06	0	0.00000	0	0.000E+00		
			197	1.33	2.281E+06	0	0.00000	0	0.000E+00		
			198	3.20	5.488E+06	0	0.00000	0	0.000E+00		
			4		4.523E+06 1.809E+07		0.00000		0.000E+00		
	18	-26.88	185	3.68	6.311E+06	0	0.00000	0	0.000E+00		
			186	0.35	6.002E+05	0	0.00000	0	0.000E+00		
			187	4.07	6.980E+06	0	0.00000	0	0.000E+00		
			191	2.93	5.025E+06	0	0.00000	0	0.000E+00		
			192	5.02	8.611E+06	0	0.00000	0	0.000E+00		
			193	2.29	3.927E+06	1	0.00018	2	3.757E-07		
			194	4.77	8.180E+06	0	0.00000	0	0.000E+00		
			195	5.08	8.712E+06	0	0.00000	0	0.000E+00		
			203	3.32	5.694E+06	0	0.00000	0	0.000E+00		
			9		6.004E+06 5.404E+07		0.00002		4.175E-08		
	19	-26.88	202	3.70	6.345E+06	0	0.00000	0	0.000E+00		
			204	4.30	7.374E+06	0	0.00000	0	0.000E+00		
			2		6.860E+06 1.372E+07		0.00000		0.000E+00		

Table 4 (cont.). Biomass and backscatter estimates, for St. Mary's Bay - Placentia Bay, from the 1992 acoustic survey.

STOCK AREA	STRATUM	TARGET STRENGTH (dB/kg)	TRANSECT NUMBER	TRANSECT LENGTH (n.mi.)	TRANSECT AREA (m ²)	TRANSECT BIOMASS (t)	WEIGHTED DENSITY (kg/m ²)	TRANSECT TOTAL SCATTER (m ² /sr)	WEIGHTED SCATT. COEFF. (/sr)	SET NUMBER	NUMBER OF FISH SAMPLED
		21	-26.88	205	1.12	1.921E+06	0	0.00000	0	0.000E+00	
				206	1.21	2.075E+06	0	0.00000	0	0.000E+00	
				207	1.21	2.075E+06	0	0.00000	0	0.000E+00	
				211	0.85	1.458E+06	0	0.00000	0	0.000E+00	
				212	0.83	1.423E+06	0	0.00000	0	0.000E+00	
				5		1.790E+06 8.952E+06		0.00000		0.000E+00	
		22	-26.88	208	1.69	2.898E+06	0	0.00000	0	0.000E+00	
				209	2.18	3.739E+06	0	0.00000	0	0.000E+00	
				210	0.72	1.235E+06	0	0.00000	0	0.000E+00	
				213	2.12	3.636E+06	0	0.00000	0	0.000E+00	
				214	1.83	3.138E+06	0	0.00000	0	0.000E+00	
				215	0.58	9.947E+05	0	0.00000	0	0.000E+00	
				6		2.607E+06 1.564E+07		0.00000		0.000E+00	
		23	-26.88	216	0.94	1.612E+06	0	0.00000	0	0.000E+00	
				217	4.94	8.472E+06	0	0.00000	0	0.000E+00	
				218	4.23	7.254E+06	0	0.00000	0	0.000E+00	
				219	3.72	6.380E+06	0	0.00000	0	0.000E+00	
				4		5.929E+06 2.372E+07		0.00000		0.000E+00	
		24	-26.88	220	4.66	7.992E+06	0	0.00000	0	0.000E+00	
				221	4.76	8.163E+06	0	0.00000	0	0.000E+00	
				222	5.28	9.055E+06	0	0.00000	0	0.000E+00	
				3		8.403E+06 2.521E+07		0.00000		0.000E+00	
		25	-26.88	223	5.22	8.952E+06	0	0.00000	0	0.000E+00	
				224	2.71	4.648E+06	0	0.00000	0	0.000E+00	
				2		6.800E+06 1.360E+07		0.00000		0.000E+00	

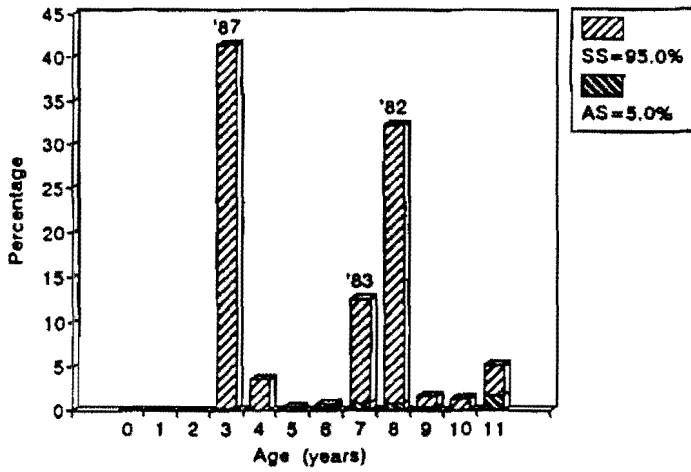
Table 5. Biomass and backscatter estimates, by stratum, for Fortune Bay and St. Mary's Bay-Placentia Bay, from the 1992 herring acoustic survey.

Stock area	Stratum	Target strength (dB kg ⁻¹)	Stratum area (m ²)	Stratum biomass density (kg m ⁻²)	Total biomass (t)		Stratum area scatt. coeff. (sr ⁻¹)	Total backscattering (m ² sr ⁻¹)	
					Mean	S.E.		Mean	S.E.
FB	1	-	1.972 x 10 ⁸	0.00000	0	-	0.000	0	-
	2	-25.55	7.170 x 10 ⁷	0.08546	6127	6154	2.379 x 10 ⁻⁴	17059	17132
	3	-	7.260 x 10 ⁷	0.00000	0	-	0.000	0	-
	4	-	3.181 x 10 ⁸	-	-	-	-	-	-
	5	-	9.240 x 10 ⁷	0.00000	0	-	0.000	0	-
	6	-27.60	9.080 x 10 ⁷	0.00157	143	152	2.729 x 10 ⁻⁶	248	264
	7	-	3.390 x 10 ⁷	0.00000	0	-	0.000	0	-
	8	-	4.660 x 10 ⁷	0.00000	0	-	0.000	0	-
	9	-29.63	2.920 x 10 ⁷	0.02168	633	595	2.361 x 10 ⁻⁵	690	648
	10	-	2.840 x 10 ⁷	0.00000	0	-	0.000	0	-
	11	-26.25	4.180 x 10 ⁷	0.01017	425	390	2.411 x 10 ⁻⁵	1008	925
	12	-	5.680 x 10 ⁷	0.00000	0	-	0.000	0	-
	13	-	3.110 x 10 ⁸	0.00000	0	-	0.000	0	-
	14	-	1.847 x 10 ⁸	0.00000	0	-	0.000	0	-
Combined			1.575 x 10 ⁹		7328	6196		19004	17171
SMB-PB	1	-	6.149 x 10 ⁸	0.00000	0	-	0.000	0	-
	2	-	6.565 x 10 ⁸	0.00000	0	-	0.000	0	-
	3	-	3.773 x 10 ⁸	0.00000	0	-	0.000	0	-
	4	-	4.057 x 10 ⁸	0.00000	0	-	0.000	0	-
	5	-26.88	4.340 x 10 ⁷	0.00061	27	26	1.254 x 10 ⁻⁶	54	53
	6	-	6.950 x 10 ⁷	0.00000	0	-	0.000	0	-
	7	-	9.390 x 10 ⁷	0.00000	0	-	0.000	0	-
	8	-30.24	9.630 x 10 ⁷	0.06066	5842	3350	5.736 x 10 ⁻⁵	5524	3167
	9	-	1.484 x 10 ⁸	0.00000	0	-	0.000	0	-
	10	-	9.000 x 10 ⁷	0.00000	0	0	0.000	0	-
	11	-25.87	9.240 x 10 ⁷	0.02275	2102	2127	5.892 x 10 ⁻⁵	5444	5510
	12	-26.01	4.970 x 10 ⁷	0.01389	690	676	3.482 x 10 ⁻⁵	1730	1694
	13	-	7.420 x 10 ⁷	0.00000	0	-	0.000	0	-
	14	-	8.370 x 10 ⁷	0.00000	0	-	0.000	0	-
	15	-	6.870 x 10 ⁷	0.00000	0	-	0.000	0	-
	16	-	9.790 x 10 ⁷	0.00000	0	-	0.000	0	-
	17	-	1.287 x 10 ⁸	0.00000	0	-	0.000	0	-
18	-26.88	2.234 x 10 ⁸	0.00002	5	5	4.175 x 10 ⁻⁸	9	10	
19	-	5.241 x 10 ⁸	0.00000	0	-	0.000	0	-	
20	-	6.000 x 10 ⁸	0.00000	0	-	0.000	0	-	
21	-	1.247 x 10 ⁸	0.00000	0	-	0.000	0	-	
22	-	7.030 x 10 ⁷	0.00000	0	-	0.000	0	-	
23	-	2.384 x 10 ⁸	0.00000	0	-	0.000	0	-	
24	-	5.154 x 10 ⁸	0.00000	0	-	0.000	0	-	
25	-	6.433 x 10 ⁸	0.00000	0	-	0.000	0	-	
Combined			6.031 x 10 ⁹		8665	4026		12762	6577

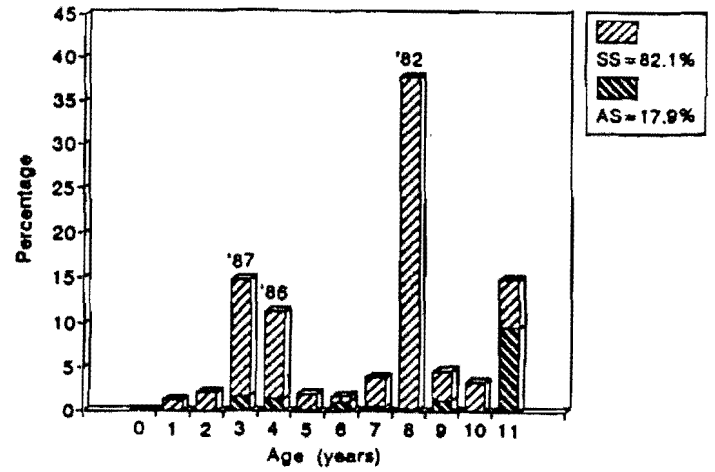
Table 6. Population numbers at age ($\times 10^6$), as estimated from the 1990 and 1992 winter acoustic surveys for Fortune Bay and St. Mary's Bay-Placentia Bay.

Year-class	Fortune Bay				St. Mary's Bay-Placentia Bay			
	1990		1992		1990		1992	
	AS	SS	AS	SS	AS	SS	AS	SS
1991	-	-	0.0	0.2	-	-	0.0	18.7
1990	-	-	0.0	7.6	-	-	0.0	0.8
1989	0.0	0.0	0.0	0.2	0.0	0.8	0.0	0.6
1988	0.0	0.0	0.0	0.3	0.0	1.4	0.3	0.3
1987	0.1	12.8	0.0	4.1	1.1	7.9	1.2	5.5
1986	0.0	1.1	<0.1	0.3	0.9	6.0	0.9	3.6
1985	0.0	0.1	0.0	0.0	0.1	1.1	0.3	0.9
1984	0.1	0.1	0.0	0.2	0.7	0.4	0.3	0.3
1983	0.3	3.6	0.0	2.1	0.3	2.0	0.5	1.0
1982	0.3	9.8	0.0	8.3	0.2	22.7	0.0	5.3
≤1981	0.7	1.9	0.2	4.7	6.6	7.3	1.8	4.2
	1.6	29.5	0.2	27.8	10.8	49.7	5.2	41.2

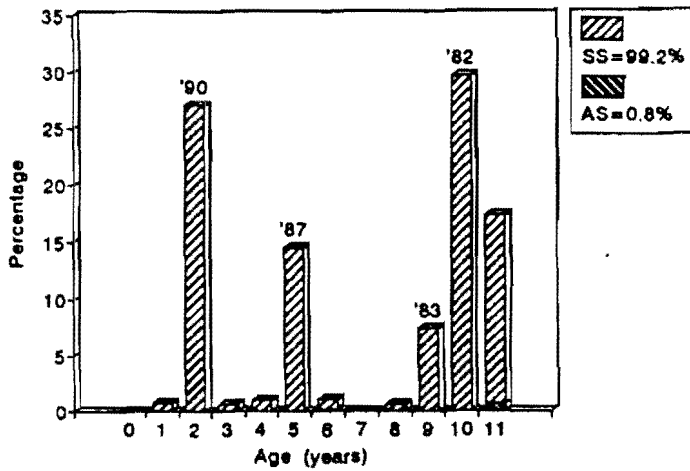
FB 1990



SMB-PB 1990



FB 1992



SMB-PB 1992

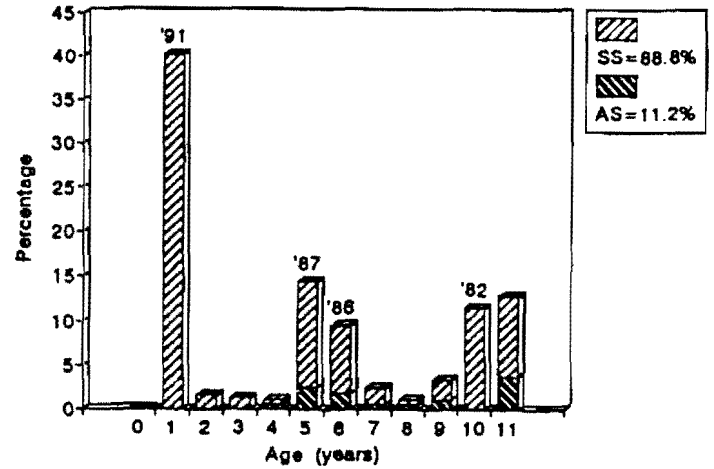
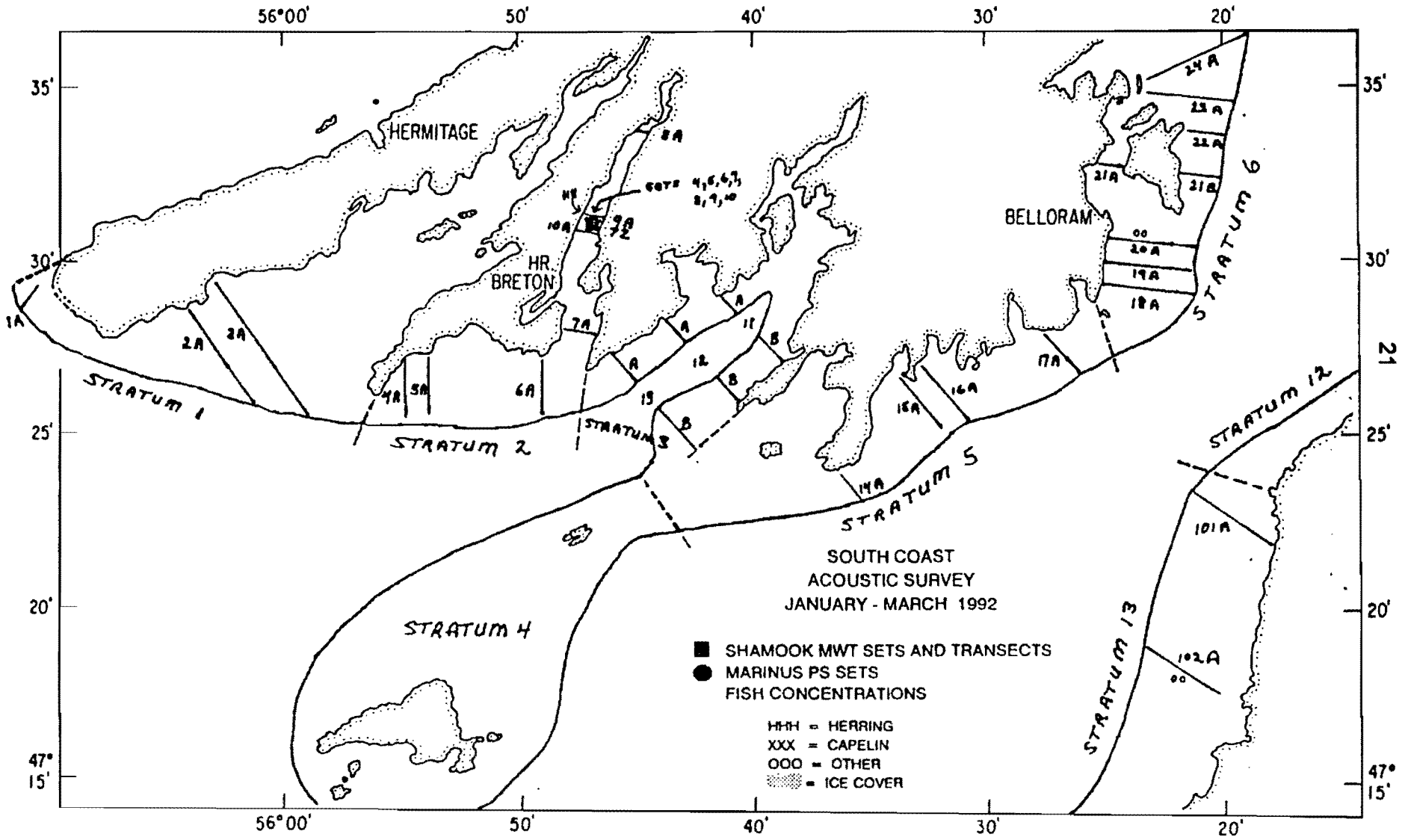
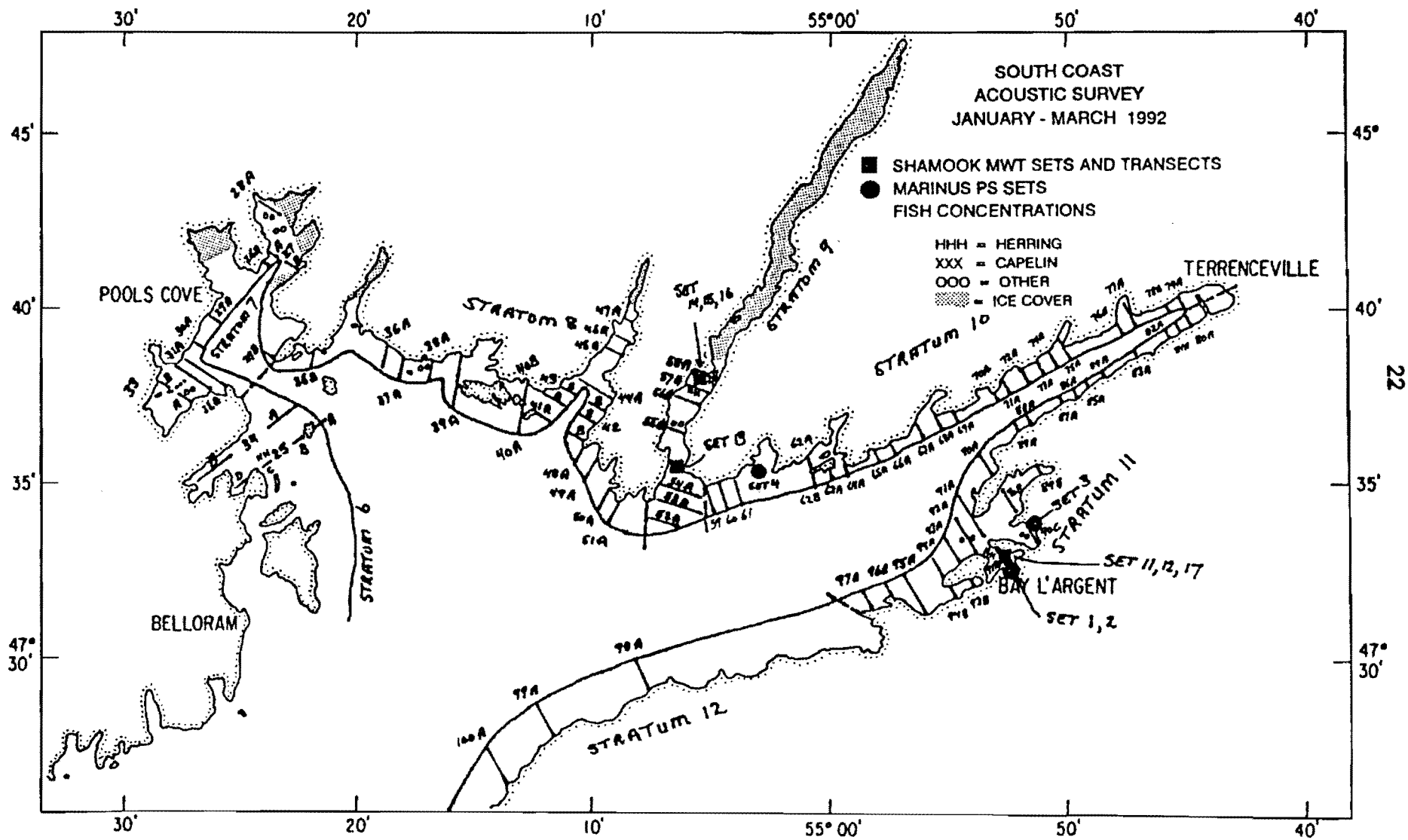


Fig. 1. Stock age distribution of herring from the 1990 and 1992 acoustic surveys, for Fortune Bay (FB) and St. Mary's Bay - Placentia Bay (SMB-PB).

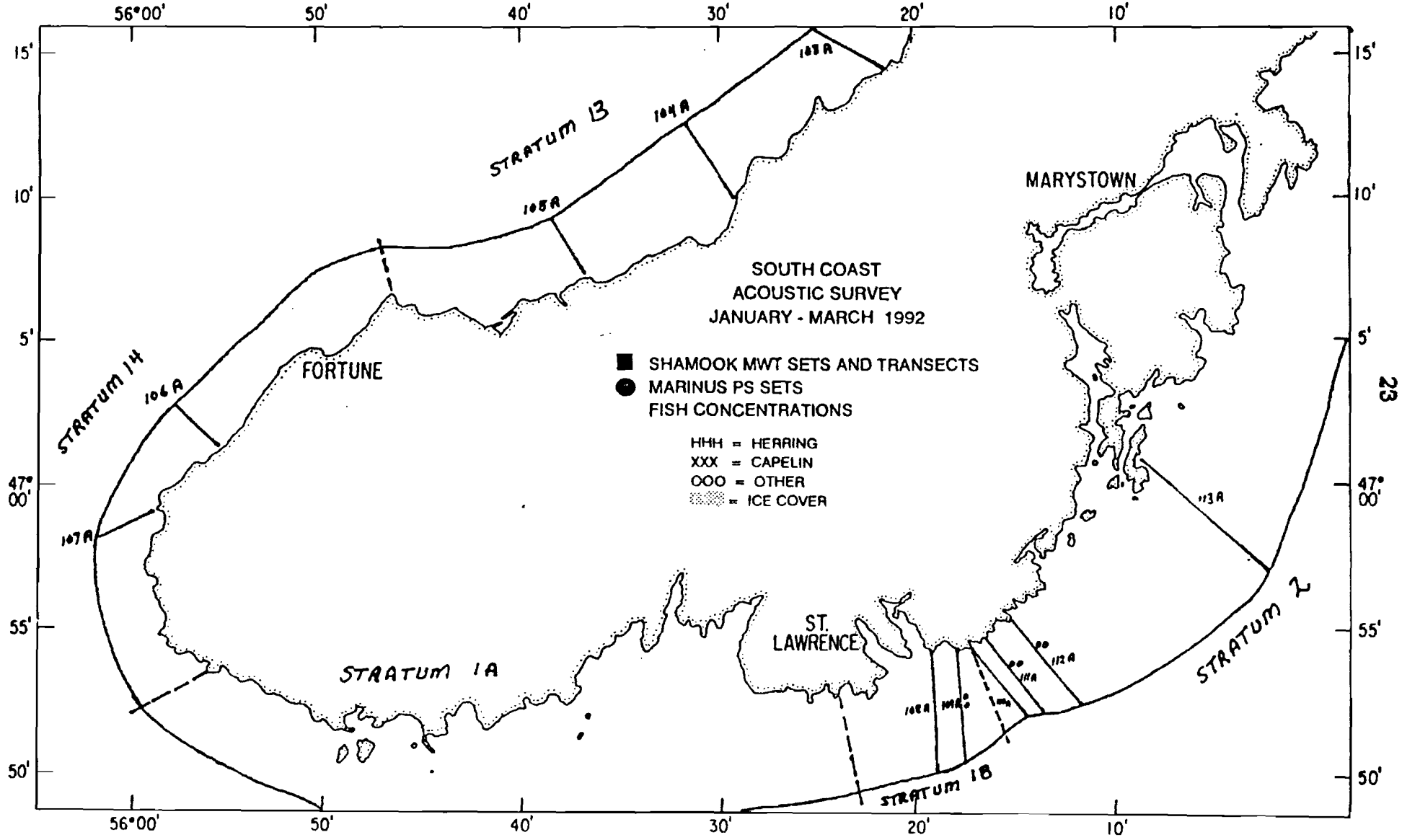
Appendix 1. Transects and set locations during the 1992 acoustic survey for the outer portion of Fortune Bay.



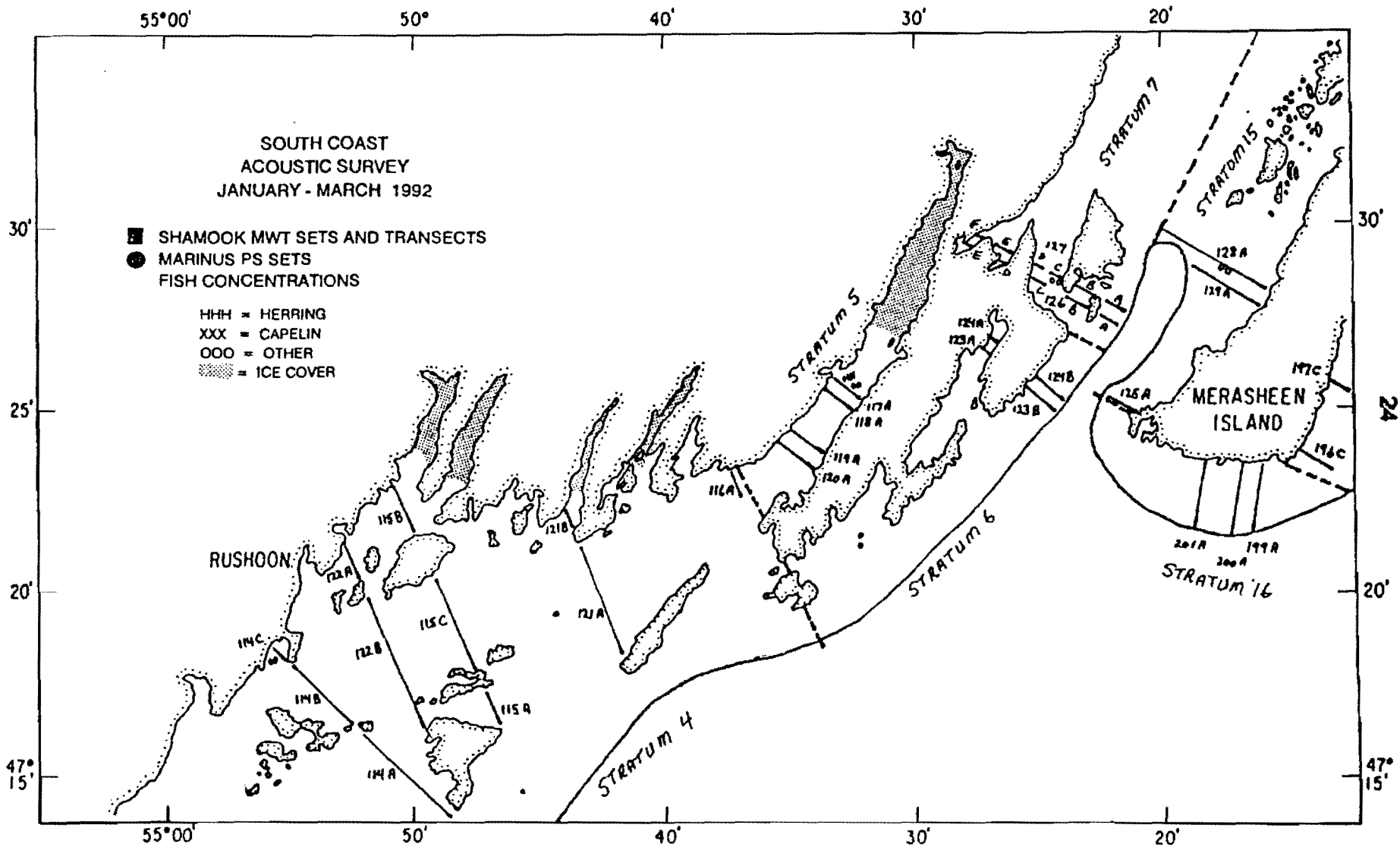
Appendix 2. Transects and set locations during the 1992 acoustic survey for the inner portion of Fortune Bay.

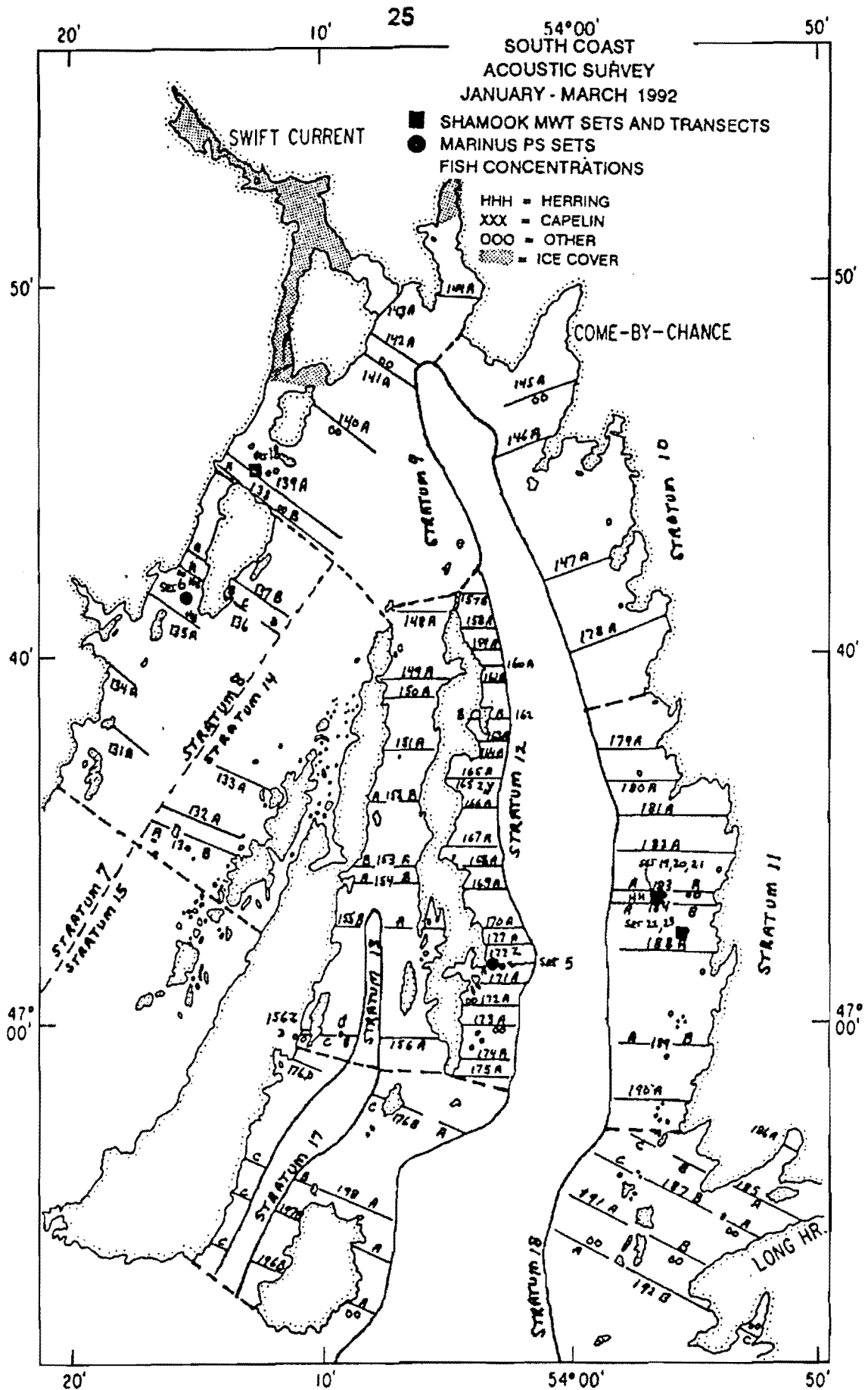


Appendix 3. Transects and set locations during the 1992 acoustic survey for Fortune to Marystown.

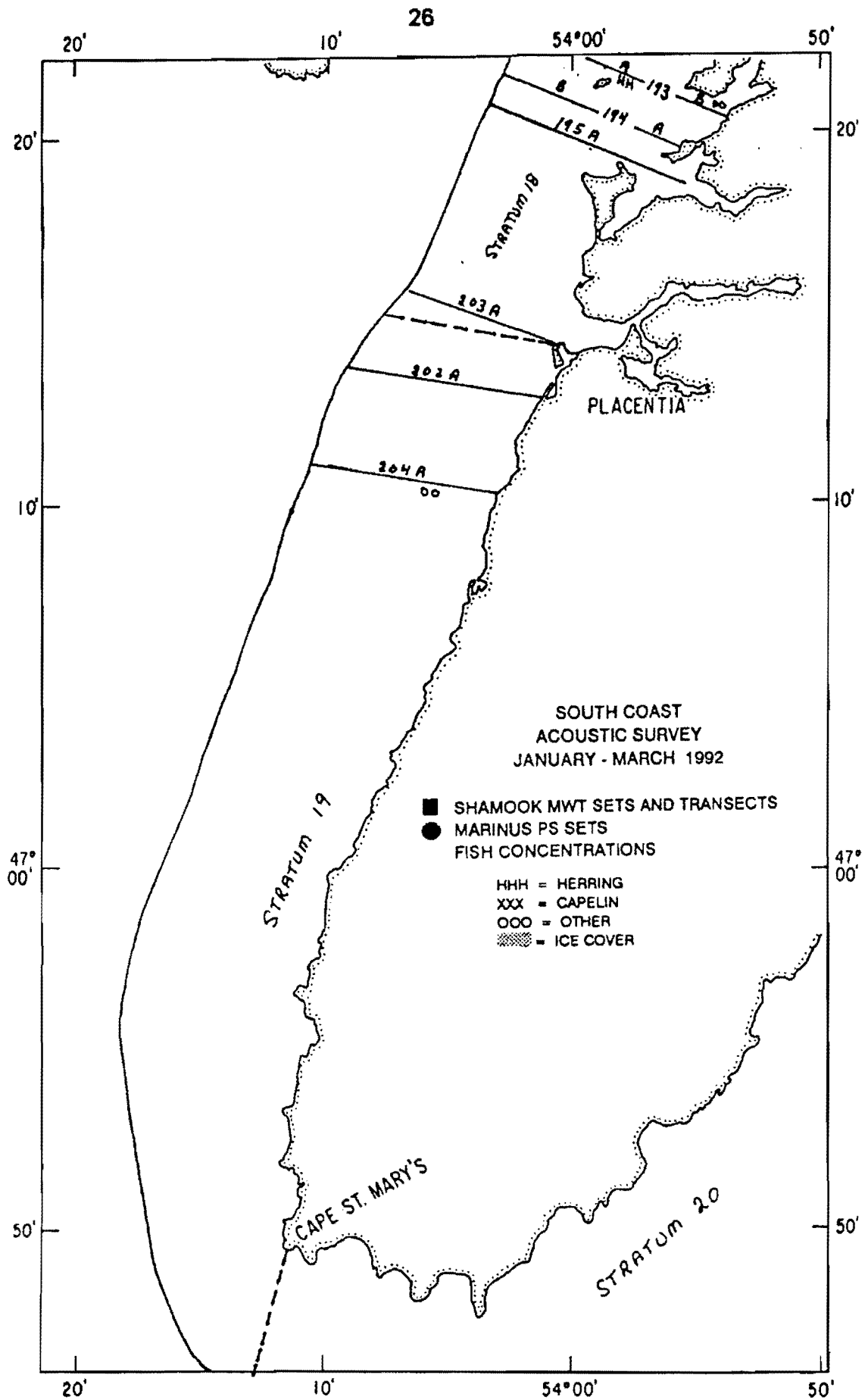


Appendix 4. Transects and set locations during the 1992 acoustic survey for the west side of Placentia Bay.

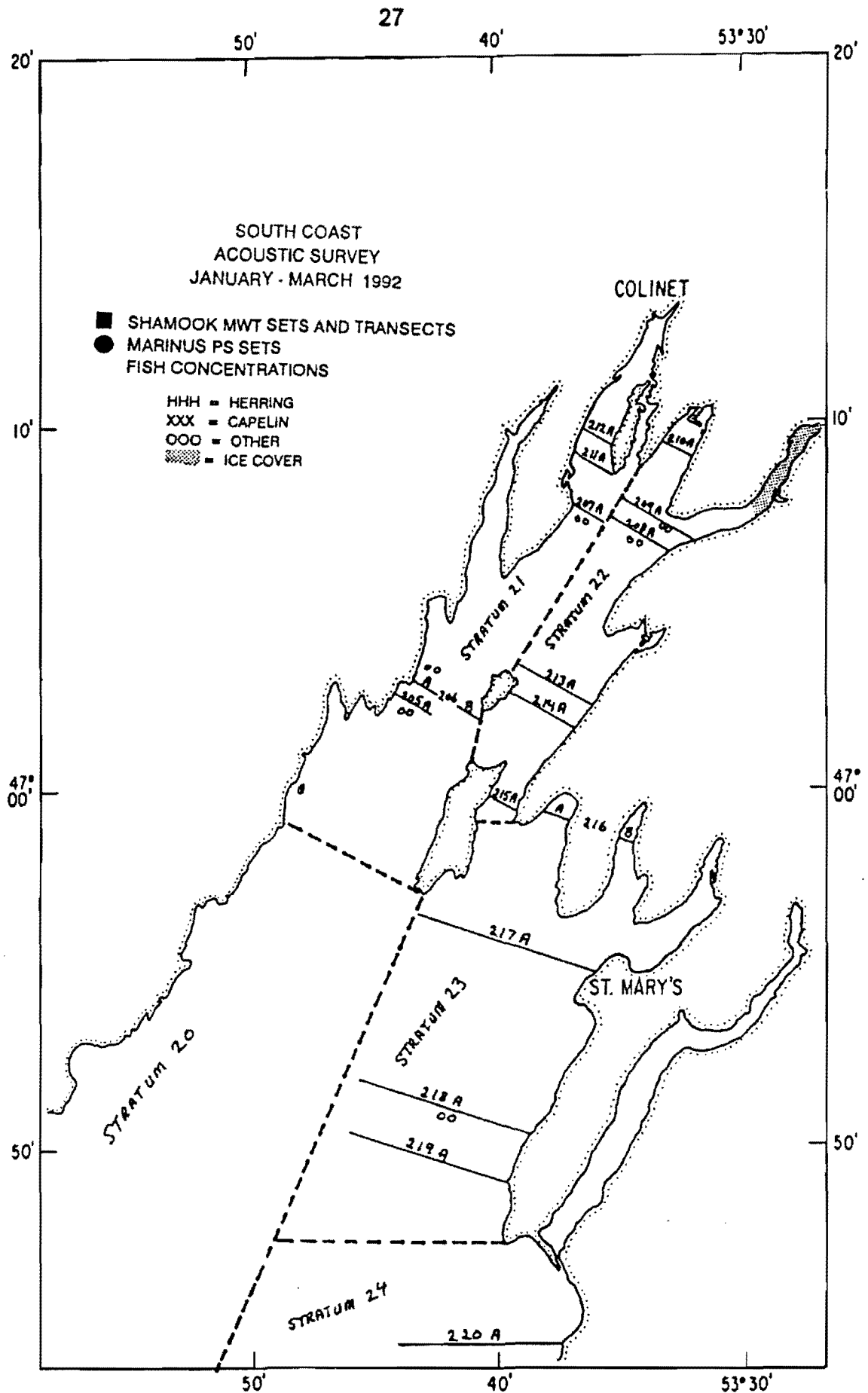




Appendix 5. Transects and set locations during the 1992 acoustic survey for the inner portion of Placentia Bay.

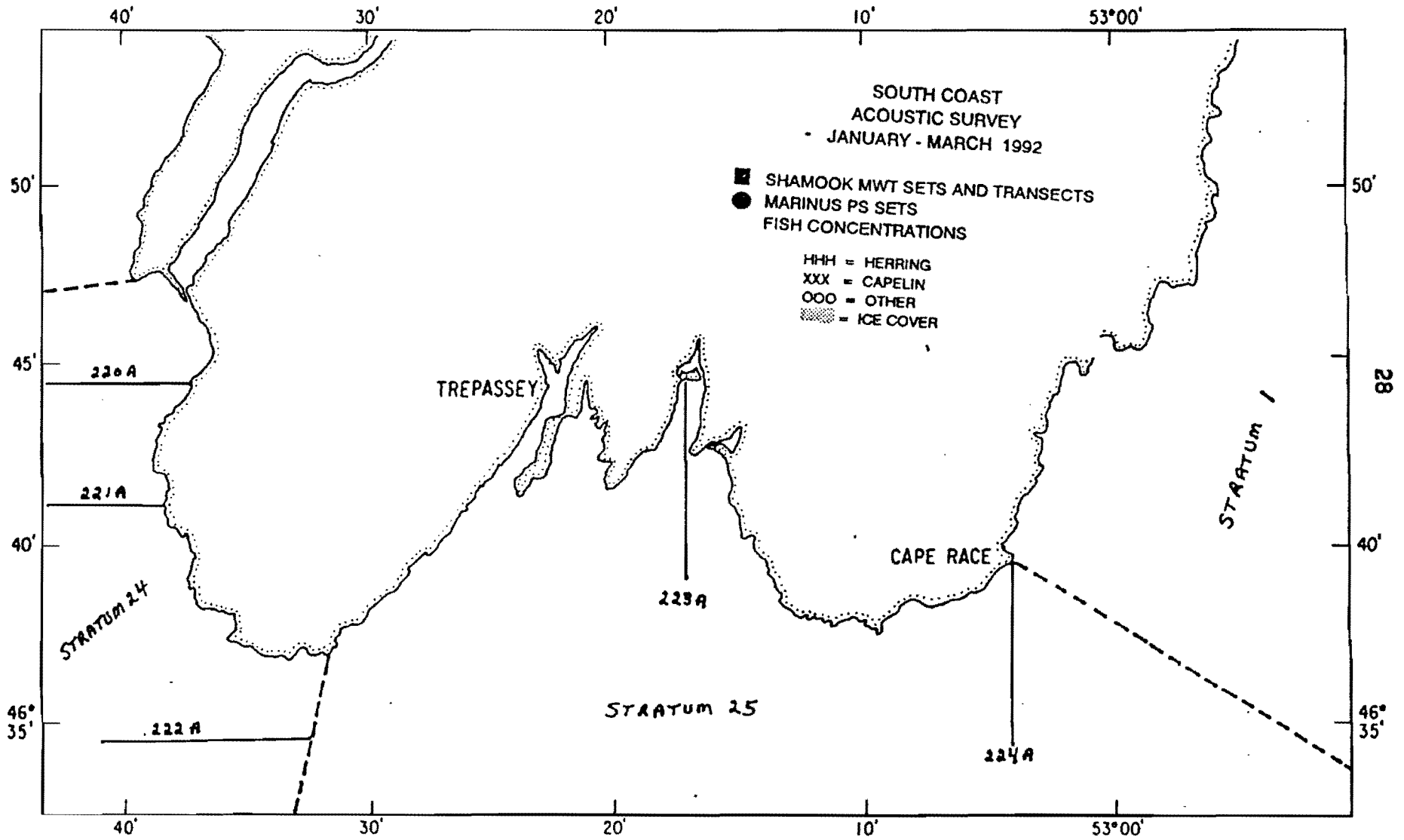


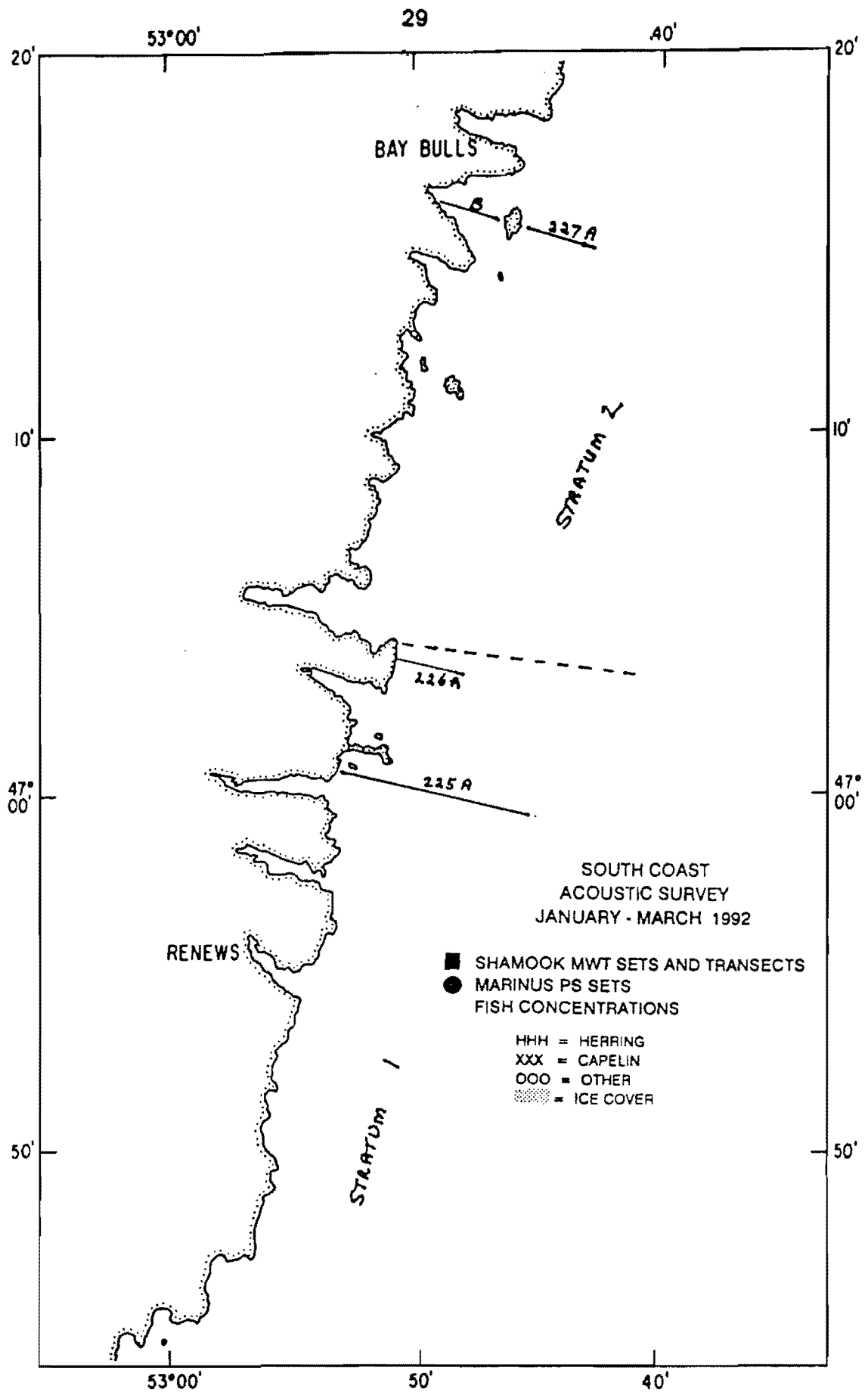
Appendix 6. Transects and set locations during the 1992 acoustic survey for the east side of Placentia Bay.



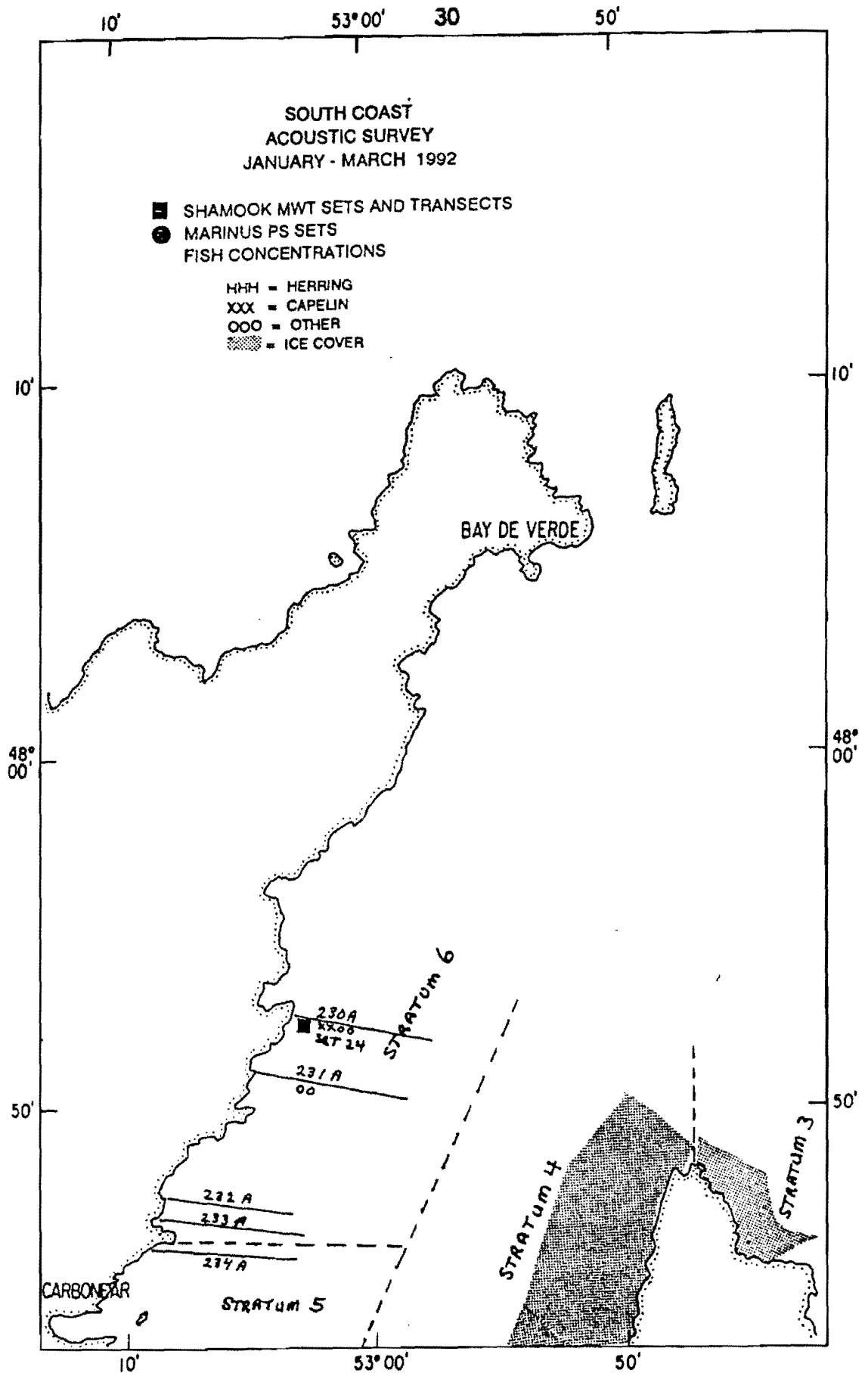
Appendix 7. Transects and set locations during the 1992 acoustic survey for St. Mary's Bay.

Appendix B. Transects and set locations during the 1992 acoustic survey for Trepassey Bay.





Appendix 9. Transects and set locations during the 1992 acoustic survey for the Southern Shore.



Appendix 10. Transects and set locations during the 1992 acoustic survey for the outer portion of Conception Bay.

