Newfoundland East and Southeast Coast Herring - 1988 Assessment

by

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Abstract

Data analyses from 1988 are presented for the five herring stock complexes within the Newfoundland Region: 1) White Bay-Notre Dame Bay, 2) Bonavista Bay-Trinity Bay, 3) Conception Bay-Southern Shore, 4) St. Mary's Bay-Placentia Bay, and 5) Fortune Bay. Commercial landings decreased from 22,600 t in 1987 to 19,200 t in 1988. All stocks continue to be dominated by the single 1982 year-class which appears to be of moderate strength in relation to the previous large 1968 year-class. Biomass estimates are calculated for the two northern stock areas from an acoustic survey conducted in the fall of 1988. Information from the research gillnet program in each of the five stock areas is reviewed to examine both the trends in catch rates of spring and autumn spawning components and the relative strengths of recent year-classes.

Résumé

On présente des analyses de données recueillies en 1988 portant sur les cinq concentrations de stocks de hareng de la région de Terre-Neuve, soit celles des 1) baies de White et de Notre Dame: 2) baies de Bonavista et de Trinity; 3) baie de Conception et côte sud; 4) baies de St. Mary et de Placentia et 5) baie de Fortune. Les débarquements commerciaux sont passés de 22 600 t en 1987 à 19 200 t en 1988. Une seule classe d'âge, soit celle de 1982, continue de dominer les stocks, mais si on la compare à la forte classe de 1968 qui prédominait antérieurement, son effectif est plus modeste. On fournit des estimations de biomasse des deux stocks du nord, fondées sur un relevé acoustique effectué à l'automne 1988. Enfin, on examine des données recueillies dans le cadre du programme de recherche au filet maillant pour chacun des cinq stocks considérés afin de déterminer les tendances des taux de prise parmi les reproducteurs du printemps et d'automne et la force relative des classes d'âge récentes.

Introduction

Description of the Fishery

The 1988 herring management plan provided an allowance for fixed gear (gillnets and traps) within each stock area (Fig. 1) with allocations to bar seines and purse seines based on TAC residuals and/or market considerations. Advised catch levels and allocations by fleet sector and stock area were as follows:

Stock area	TAC (t)	Fixed gear allowance (t)	Bar seine (t)	Purse seine (t)	Reserve (t)
White Bay-Notre Dame Bay (WB-NDB)	34,700	6,000	1,000 1,500	5,000 5,000	16,200
Bonavista Bay-Trinity Bay (BB-TB)	16,200	2,500	1,000 1,000	3,000 2,000	6,700
Conception Bay-Southern Shore (CB-SS)	600	100	100 100	200 100	0
St. Mary's Bay-Placentia Bay (SMB-PB)	8,900	1,000	500 500	2,000 2,000	2,900
Fortune Bay (FB)	4,700	500	1,500	500	2,200
Labrador coast	-	500	200	0	0
South coast Newfoundland	-	100	100	0	0

As in 1987, the management plan was devised prior to the spring fishery. For all areas except Conception Bay-Southern Shore a portion of the TAC was held in reserve. The fall fishery allocations included uncaught portions of the spring fishery allocations plus a portion of the reserves, where necessary.

Nominal Catches

TACs and landings (x 10^3 t) by stock area are listed below for 1981 to 1988:

		1981	1982	1983	1984	1985	1986	1987	1988
WB-NDB	TAC	5.3	1.2	0.0	1.5	2.0	5.5	32.5	34.7
	Catch	4.7	2.0	0.4	1.5	1.8	2.7*	14.0*	7.3*
BB-TB	TAC	4.8	0.7	0.0	0.4	0.8	3.8	13.7	16.2
	Catch	4.0	0.5	0.1	0.2	0.6	1.7*	6.9*	10.1*
CB-SS	TAC	0.5	0.2	0.0	0.1	0.2	0.6	3.5	0.6
	Catch	0.2	0.1	<0.1	<0.1	0.1	0.2*	1.3*	0.5*
SMB-PB	TAC	1.2	0.0	0.0	0.0	0.6	2.1	2.5	8.9
	Catch	0.6	<0.1	<0.1	0.1	0.1	0.1*	0.3*	1.2*
FB	TAC	0.2	0.0	0.0	0.0	0.3	0.7	2.4	4.7
	Catch	0.1	<0.1	<0.1	<0.1	0.1	0.1*	0.1*	0.1*

* preliminary

Anecdotal Information

As in 1986 and 1987, quotas were not taken in most areas due to poor market conditions. However, in the two northern areas, where the fall purse seine fishery was concentrated, landings exceeded 17,000 t, comparable both with 1987 landings (20,900 t) and with the peak years of 1976-79 (Tables 1 and 2). In both of these areas, seiner skippers reported a general absence of mature fish (primarily 1982 year-class) early in the fall (September-October) and an abundance of immature fish (1985 and 1987 year-classes). There was a modest resumption of the purse seine fishery in Conception Bay-Southern Shore and St. Mary's Bay-Placentia Bay (Tables 3 and 4). Purse seine landings in Conception Bay-Southern Shore were restricted by the allocation to that gear sector. In St. Mary's Bay-Placentia Bay, purse seine landings from the winter fishery exceeded 1000 t for the first time since 1980. Landings there would have been higher if markets were available. Fortune Bay landings (Table 5) remained low due partly to a management decision not to license any purse seine vessels in the area and also to exclude other purse seine vessels from fishing there.

INPUT DATA

Biological Sampling

There were 14,894 herring sampled in 1988 from the commercial fishery and research programs (Table 6), an overall increase of 11% from 1987. The increase in sampling was due to the implementation of the research gillnet program during the spring along the northeast coast in addition to its continuation during the fall in the same areas. This resulted in an increase of 24% in the number of research samples, whereas the number of commercial samples decreased by 22%. When apportioned by stock area, month, and gear type (Table 7), samples were available for 80% of the commercial catch; down from 89% in 1987. Samples were collected randomly; all fish sampled were measured and aged.

Mean weights at age for 1988 (Table 8) were derived from commercial and research samples of spring spawning herring collected from January to June.

Commercial Fishery Data

Commercial catch-at-age data (Tables 9-13 and Figs. 2 and 3) were calculated for spring and autumn spawners for each stock area by applying age compositions and mean fish weights from the appropriate commercial samples to the landings. As in the past, catch-at-age data were generated using research samples collected from commercial mesh size gillnets for those areas where no commercial samples were available.

The 1982 year-class of spring spawners continued to dominate the fishery (by number) in all stock areas, accounting for 40% to 72% of the catch. These percentages were lower than 1987 when this year-class accounted for 53% to 80% of the catch. The 1985 year-class which last year represented 5% of the commercial catch in Bonavista Bay-Trinity Bay, this year accounted for 21% of the catch in the same area. The 1987 year-class accounted for 10% of the 1988 catch in White Bay-Notre Dame Bay. This is consistent with reports of small fish in this area during the fall purse seine fishery. There was a general absence of year-classes, other than the 1982 year-class, in the commercial catch in the two southern areas (Fig. 3). This may be partially explained for Fortune Bay in particular by the fact that there was no purse seine fishery, fixed gear only, which would be more selective to the larger fish.

The percentage of spring spawners in the catch remained high in all areas (>80%) consistent with the dominance of the 1982 year-class.

RESEARCH SURVEY DATA

A. Research Gillnet Program

The program was continued for the ninth consecutive year during the fall along the northeast coast and for the seventh year during the spring along the southeast coast. Consistent with CAFSAC's recommendation last May, the spring program for the three northern areas, which began in 1985, was expanded to include four fishermen in White Bay-Notre Dame Bay, four in Bonavista Bay-Trinity Bay and two in Conception Bay-Southern Shore. These were in addition to the five fishermen already in place in St. Mary's Bay-Placentia Bay and the three in Fortune Bay. The 14 fishermen involved in the fall gillnet program along the northeast coast continued to fish in 1988 until a decision is made to continue or terminate the fall program.

Each of the research gillnet fishermen was contracted to fish five gillnets (mesh sizes 2"-3") for one month, to maintain an accurate daily log record of catches, and to collect samples of his catch.

Catch at age (Figs. 4 and 5) were calculated by applying age distributions of samples taken during the month, normally at four-day intervals, to catches during that interval and then combining these interval age distributions into one for the entire month. The 1982 year-class again dominated (by number) in both spring and fall programs in all areas, ranging from 38% of the spring catch in White Bay-Notre Dame Bay to 76% of the spring catch in Fortune Bay. However, similar to and independent of age distribution the commercial fishery (Fig. 2), the 1985 year-class was evident in the research gillnet catches during the fall in both Bonavista Bay-Trinity Bay (15%) and Conception Bay-Southern Shore (25%). However, it didn't dominate the catches as did the 1982 year-class as three-year-olds in 1985 (35-65%). Fish aged 11+ continued to account for greater than 10% of the catch in White Bay-Notre Dame Bay. This percentage decreased in the southern areas. The 1982 year-class continued to totally dominate the catches in the two southern areas. In Fortune Bay, year-classes subsequent to the 1982 year-class have been totally absent from research gillnet catches in each of the past four years. This is also consistent with the commercial catch at age for this area. The percentage of spring-spawners continued to increase, ranging from 83% in St. Mary's Bay-Placentia Bay to 98% in Conception Bay-Southern Shore.

The evaluation of the fall research gillnet program, as recommended last year by CAFSAC, is not yet complete. However, as a first step, daily catch rates for individual fishermen have been broken down by spawning component, to determine if temporal trends exist.

Catch rates at age, by area and season, (Tables 14-21) are summarized in Table 22 and Figures 6-9. In most areas, catch rates declined from 1987 to 1988.

For the spring program, catch rates of spring spawners have declined from 1987 to 1988 in Bonavista Bay-Trinity Bay, St. Mary's Bay-Placentia Bay, and Fortune Bay. However, they have increased in Conception Bay-Southern Shore and are in fact the highest on record for either season in any of the stock areas. Both fishermen in the area had increased catch rates; however, one fisherman dominated having averaged 1809 fish per days fished. Of the 60,353 fish that he caught, over 50% were caught in a three day period when the fisherman reported an abundance of herring in the harbour. In the following days, his catch rates dropped substantially.

The spring series in the two southern areas continued to show the most consistent trends over time with spring spawner catch rates peaking in 1987 and declining in 1988 (Tables 20 and 21). As stated last year (Wheeler et al. 1988) this may be due to the fact that overwintering non-migrating concentrations are being fished. The series is also consistent for these two areas in particular as there is basically a single year-class being fished (Fig. 5). The spring series in the northern areas exhibit greater variability due the small sample sizes in earlier years.

The fall series, in their present form, may not reflect stock abundance as the nets are fished at a time when fish are migrating and catch rates may be affected by temporal changes in migration patterns. This is presently being

investigated to determine if the series can provide an indication of stock abundance.

A preliminary analysis of research gillnet data from one area was conducted using the multiplicative model (Table 23). St. Mary's Bay-Placentia Bay was chosen for the analysis as this area provided one of the more consistent time series of data and it was felt that trends exhibited there may be indicative of adjacent stock areas. Catch rates from the model showed similar trends to the unadjusted catch rates, increasing to 1987 and decreasing in 1988. Although initial results looked promising, more detailed analyses are required before further conclusions can be drawn.

B. Acoustic Survey

An acoustic survey was conducted from October 23, 1988 to December 8, 1988, from Cape Bauld in the north to Cape St. Francis in the south. The survey included the two northern stock areas: White Bay-Notre Dame Bay and Bonavista Bay-Trinity Bay and the Conception Bay portion of the Conception Bay-Southern Shore stock complex. A BioSonics dual beam hydroacoustic system was deployed from the R.V. SHAMOOK during the survey. The R.V. MARINUS, equipped with a herring purse seine, was attendant during the entire survey to collect biological samples.

Each of the stock areas were divided into low, medium, and high density strata based upon distributional patterns observed during previous (1985-87) surveys. White Bay-Notre Dame Bay was divided into 11 strata (Appendices 1-7), Bonavista Bay-Trinity Bay into 12 strata (Appendices 8-14), and Conception Bay into one stratum only (Appendices 14 and 15). Conception Bay was not divided into more strata as there was insufficient distributional information from previous surveys. It was decided prior to the survey to allocate sampling intensity (total transect length) on a 3:2:1 ratio between high, medium, and low density areas, respectively.

Subsequent to the analysis of results of the 1987 acoustic survey, which indicated that there may have been herring outside the area surveyed (Wheeler et al. 1988), the outer boundary of each of the stock areas was extended from 90 m to 120 m.

The survey design consisted of a series of randomly selected parallel transects from shore to the 120 m depth contour, with a minimum of three transects in each stratum. Each transect was surveyed at a vessel speed of 6.0 K. Navigational error dictated that transects be spaced a minimum of 926 m (0.5 n mi) apart. Reference lines were drawn parallel to the coastline. Random transects were chosen perpendicular to these lines given the constraint of 926 m separation between transects. Due to the irregular nature of the coastline, transects within strata were of unequal length.

Biological sampling was inadequate during the survey (Table 24). There were only 12 purse seine sets during the 31 survey days. Immature (1987 and 1988 year-classes) herring were caught in four sets only. There were no mature fish taken in any sets. In order to calculate mean fish lengths and weights, by stratum, as is necessary for the fish length-target strength per kg relationship and for estimating population numbers at age, commercial samples caught within 30 days of the survey dates within a stratum, were combined with research samples taken during the survey in that stratum (Table 25) were used for this purpose.

Since both commercial and research samples had to be used to calculate population numbers at age from the survey, age distributions (Fig. 10) are very comparable to those from the commercial fishery (Fig. 2). The 1982 year-class dominated, by numbers, in all three areas. In Bonavista Bay-Trinity Bay and Conception Bay the 1985 year-class was the second most abundant. In White Bay-Notre Dame Bay, the 1987 year-class was second largest, approximately equal to the 1982 year-class. In White Bay-Notre Dame Bay, the 1982 year-class has been strong in all recent acoustic surveys. The 1983 year-class has been 20-40% the size of the 1982 year-class each of the past three years. The 1985 year-class has represented <5% of the population each of the past three years. The 1987 year-class which represented 11% of the population last year at age 0 continued to show strength at 30% this year. In Bonavista Bay-Trinity Bay, the 1982 year-class has been strong in three of the four surveys. Similarly, the 1983 year-class has remained approximately 20% the size of the 1982 year-class each of the last two years. It was only in 1986 that the 1982 year-class did not dominate; during that survey the 1985 year-class as one-year-olds represented 60% of the population. At the time (Wheeler and Chaulk 1987) it was felt that sampling may have been biased towards this year-class. However, the same year-class now represents 24% of the population numbers from the 1988 survey. It also represented 10% of the population as 0 age group in 1985. The 1987 year-class, apparent in White Bay-Notre Dame Bay, has not been evident in Bonavista Bay-Trinity Bay in either 1987 or 1988.

A two-staged process was used to identify herring concentrations for inclusion in data analysis. All fish schools, regardless of species, were first identified from chart recorder tracings and acoustic logbook observations recorded during the survey. Detected voltages from all other sources were eliminated prior to further analysis. The shape of the echo trace of each of the fish schools was then viewed with an oscilloscope to distinguish between herring, mackerel, capelin and cod. This method involves examination of peak voltage amplitudes, voltage peak to trough distances and distance between voltage peaks. Although not used for herring before, the methodology is based on similar analyses, incorporating discriminant functions, for the identification of capelin, mackerel and cod schools (Rose and Leggett 1988). There was insufficient groundtruthing to develop a discriminant function for herring based upon the 1988 survey results. This will be pursued further in future surveys.

Of the schools eliminated from the analysis (Table 26), most were from White Bay and were identified as either capelin or mackerel. This is consistent with information from other sources. Although this is the first year that capelin have been detected inshore in White Bay during the herring survey, there were concentrations detected offshore (>200 m) in the same area at the same time from a capelin acoustic survey (Miller 1989). White Bay is also the area where most of the commercial mackerel fishery is concentrated in the fall.

C. Observations Aboard Commercial Purse Seine Vessel, Placentia Bay, February 1989

In early February 1989, research personnel boarded a commercial purse seine vessel in Placentia Bay for a 24 hour period to observe commercial fishing operations, to derive biological samples and to obtain qualitative information on abundance of herring. The vessel was fishing in the Long Harbour area of Placentia Bay (Fig. 1). A hydroacoustic system was not available to be placed aboard the vessel.

During the nine hours that the vessel was searching, 59 different schools of fish (potentially herring) were measured in two dimensions (from sounder tracings): 1) cross-sectional distance (i.e. length or width) and 2) depth. Most of the schools were relatively small, 10-50 m long and 5-20 m deep. The seiner skipper reported that there were three or four large schools upon which they had been concentrating their fishing effort. Of these, the following two were measured in three dimensions (the third dimension determined via sonar):

School	Dimensions	Volume
1	380 m x 70 m x 9 m	239,400 m^3
2	175 m x 160 m x 28 m	784,000 m^3

Biological samples taken by purse seine from one of the large schools yielded the following age distributions:

Age	% AS	% SS
1	-	-
2	-	5.0
3	1.0	9.0
4	1.0	1.0
5	3.0	-
6	-	-
7	7.0	24.0
8	2.0	3.0
9	4.0	11.0
10	11.0	-
11+	15.0	3.0
Total	44.0	56.0

This age distribution differs from the 1988 commercial catch at age; there is a greater percentage of autumn spawners and more immature fish (14% 1986 and 1987 year-classes). It was the contention of the skipper that many of the smaller schools observed were immature herring and therefore not marketable. He also stated that there were concentrations of mature fish in other parts of the bay but

because of quota restrictions and the convenience of location that they fished only the Long Harbour area.

ASSESSMENT RESULTS

A. Estimation of Stock Sizes from the Acoustic Survey

Integration data were collected along 447 transects. In addition, dual-beam data were collected for in situ target strength estimation by backtracking over 39 transects on which fish concentrations had been detected. However, as there was no ground-truthing (purse seine sets) to identify the target species, it was impossible to use the in situ target strength data to quantify the integration estimates. Controlled in situ experiments are planned within the next year to address this problem.

Foote's (1987) relationship between target strength and fish length was used to convert from acoustic backscatter to biomass. Mean fish lengths and weights, by stratum (Table 25) were used to calculate a target strength (dB per kg) for each stratum. The formulas used to calculate mean densities, variances and biomass estimates from the acoustic survey (Appendix 16) were derived from Jolly and Hampton (1989) and Jolly and Smith (1989). Density estimates, by transect and stratum, are presented in Tables 27-29. These are summarized by stock area in Tables 30-32. Certain transects (Tables 27-29) had to be combined to calculate density estimates as they were not independently selected but rather chosen from a single point along a reference line.

An estimate was made of the contribution of individual concentrations of fish to the estimate of population numbers (Fig. 11). In White Bay-Notre Dame Bay, no single concentration accounted for more than 18% of the population total; however, in Bonavista Bay-Trinity Bay, one concentration in stratum 15 accounted for approximately 40% of the total population estimate. This is also reflected in the coefficient of variation; for White Bay-Notre Dame Bay C.V. = 0.314, and for Bonavista Bay-Trinity Bay C.V. = 0.472. If this concentration had not been encountered, the biomass estimate for stratum 15 would have decreased from 69,313 t to 11,487 t and the C.V. for Bonavista Bay-Trinity Bay would have been 0.384.

Stock boundaries were extended from 90 m in 1987 to 120 m in 1988 based upon a relationship between the estimate of fish numbers to water depth (Wheeler et al. 1988) which suggested herring may be found in depths greater than 90 m. This was examined based upon results of the 1988 survey (Fig. 12). For both White Bay-Notre Dame Bay and Bonavista Bay-Trinity Bay, the relationship between mean total relative density (v^2) per 185 m (i.e. one minute) showed that all fish detected were within the 140 m contour and that greater than 95% were detected within the 110 m contour. This suggests that for future surveys, the 120 m contour (as used this year) is an appropriate outer stock limit.

Besides variance due to survey design and to target strength estimation, the variance in calibration parameters of the hydroacoustic system is the third major source of variance which must be accounted for in deriving population estimates from acoustic surveys. The hydroacoustic system used during the 1988 survey was calibrated by BioSonics Inc. on October 10, 1988 immediately prior to the survey (Appendix 17). In addition, the system was calibrated with a standard target at regular intervals during the survey. The sphere supplied initially was not the

proper one calibrated for the 120 kHz system being used. However, as seen from the following text table, it provided consistent results during the survey.

Date	T.S. (db) Std. Target
November 7	-33.4
November 8	-33.0
November 15	-33.1
November 18	-33.8
November 28	-40.7

The last measurement (-40.7 dB) was for the correct 120 kHz standard target supplied prior to the end of the survey. The calibrated target strength provided with the sphere was also -40.7 dB. The consistency of target strength measurements throughout the survey suggests that the hydroacoustic system was very stable and that calibration parameters did not vary during the survey.

Mean biomass (t) estimates by stock area from the 1987 and 1988 acoustic surveys are summarized in the following text table:

Stock area	Mean	Mean	C.V.
WB-NDB	134,655	98,945	0.314
BB-TB	45,473	134,914	0.472
CB only	-	5,849	0.770

Recognizing that the calculated variance estimates are based upon survey design only and do not include other sources of variation, it was felt that the 1988 acoustic survey provided reasonable estimates of abundance for White Bay-Notre Dame Bay and Bonavista Bay-Trinity Bay. The 1987 estimates for these areas are within the confidence limits of the 1988 survey. However, the Conception Bay estimate was rejected as the survey included only a part of the stock area and provided a coefficient of variation of 0.77.

Population numbers at age, projected to January 1989, were compared from both the 1987 and 1988 acoustic surveys (Table 33). For White Bay-Notre Dame Bay, the 1982 year-class was relatively strong in both surveys with the 1987 year-class being present in significant numbers in the 1988 survey. The 1982 year-class is very dominant in both surveys in Bonavista Bay-Trinity Bay and would be classified as a strong year-class if the 1988 survey reasonably represents current abundance levels.

Estimation of the Size of the 1982 Year-class

The 1982 year-class has dominated in the commercial fishery, the research gillnet program and the acoustic surveys for the past three years. Several data sources were examined to determine the strength of this year-class in relation to recent year-classes and to the large 1968 year-class which dominated these stocks through the 1970s.

In the fall research gillnet program in the two northern areas (Tables 14 and 16), the average catch rate of the 1982 year-class over the past five years has been 1.2 (BB-TB) to 2.7 (WB-NDB) times that of the 1979 year-class, a year-class that is considered to be weak. It must be noted that it is still uncertain whether the fall research gillnet series is an unbiased estimator of stock abundance. In the two southern areas (Tables 20 and 21), the spring catch rate series indicated that the 1982 year-class is four to seven times that of the 1980 year-class. Although the 1980 year-class is the second largest in the time series, it is not considered to be strong. The use of the multiplicative model on these data in future analyses may alter these relative estimates.

Year-class strengths for the 1977-87 year-classes in all five stock areas were predicted from an environmental model (Winters and Wheeler 1987) which related recruitment at age two to overwintering temperatures and salinities. For all stock areas (Table 34), the model predicted the 1982 year-class to be only of moderate strength (20-50% of the 1968 year-class) in White Bay-Notre Dame Bay and in Fortune Bay and weak (5-20% of the 1968 year-class) in the remaining three stock areas.

Retrospective cohort analyses were conducted using the population numbers at age from the two recent acoustic surveys. The results from the 1988 survey are given in Tables 35-38. The analyses based upon both the 1987 and 1988 estimates for White Bay-Notre Dame Bay and the 1987 estimates for Bonavista Bay-Trinity Bay predicted the 1982 year-class at age two to be approximately 40-50% that of the 1968 year-class. However, the 1988 population estimate for Bonavista Bay-Trinity Bay predicted the 1982 year-class to be equal to or larger than the 1968 year-class. Again these differences in Bonavista Bay-Trinity Bay may be due to sampling problems in 1988.

With the exception of the 1988 survey results in Bonavista Bay-Trinity Bay, all available data suggest that the 1982 year-class is less than 50% the strength of the 1968 year-class. It is also evident that the 1982 year-class is the dominant year-class in all stock areas.

Prognosis

Catch Projections

Projections were run for White Bay-Notre Dame Bay and Bonavista Bay-Trinity Bay based on population numbers at age from the October-December 1988 acoustic survey.

The following partial recruitment pattern, used last year and based upon an historical combined purse seine and gillnet fishery (Winters and Moores 1977), was used for both stock areas:

Age	2	3	4	5	6	7	8	9	10	11+
P.R.	0.10	0.35	0.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Mean weights at age (g) were those derived from samples collected during January-June, 1988.

Age	2	3	4	5	6	7	8	9	10	11+
WB-NDB	81	148	214	235	256	295	316	323	333	414
BB-TB	83	129	196	233	255	285	318	358	370	421

Natural mortality was assumed to be 0.20. Recruitment at age 2 in 1990 was assumed to be zero. $F_{0.1}$ was assumed to be 0.30.

Three options were used in projections: 1) assuming the recommended catches in 1989 and F = 0.30 in 1990, 2) assuming F = 0.30 in 1989 and 1990 and 3) assuming 1988 catch levels in 1989 and F = 0.30 in 1990. The catch ($t \times 10^3$) projections for 1990 by stock area were as follows:

		WB-NDB		BB-TB	
		1989	1990	1989	1990
Option 1	2+ Biomass	98.5	79.5	116.2	101.1
	Catch	14.0	16.5	6.9	23.4
	F 5+	0.192	0.300	0.075	0.300
Option 2	2+ Biomass	98.5	72.9	116.2	83.1
	Catch	20.8	14.9	24.9	19.2
	F 5+	0.300	0.300	0.300	0.300
Option 3	2+ Biomass	98.5	86.1	116.2	98.0
	Catch	7.3	18.0	10.1	22.7
	F 5+	0.096	0.300	0.112	0.300

Although the preliminary multiplicative model analysis of St. Mary's Bay-Placentia Bay research gillnet catch rates looked promising, CAFSAC did not have sufficient information at this time to change its advice of a precautionary TAC of 1500 t for each of the three southern areas. Research gillnet catch rate data will be reviewed at the February 1990 Pelagic Subcommittee meeting and further advice for these areas may be provided then. An acoustic survey of these stocks will also be conducted in 1990.

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Table 1. White Bay (W.B.)-Notre Dame Bay (N.D.B.) herring landings (t), by gear, 1974-88.

Year	Area	Gear						Total
		Purse seine	Ringnet	Midwater trawl	Bar seine	Gillnet	Trap	
1974	W.B.	-	8	11	53	738	632	1442
	N.D.B.	-	6	-	85	2191	312	2594
	Combined	-	14	11	138	2929	944	4036
1975	W.B.	828	-	-	46	1209	329	2412
	N.D.B.	1183	108	-	12	1631	209	3143
	Combined	2011	108	-	58	2840	538	5555
1976	W.B.	1724	487	-	18	509	246	2984
	N.D.B.	2908	3412	-	589	2242	353	9504
	Combined	4632	3899	-	607	2751	599	12488
1977	W.B.	-	1228	-	39	268	240	1775
	N.D.B.	-	4961	-	2096	2438	355	9850
	Combined	-	6189	-	2135	2706	595	11625
1978	W.B.	-	1254	-	240	1133	331	2958
	N.D.B.	-	3980	-	306	5859	311	10456
	Combined	-	5234	-	546	6992	642	13414
1979	W.B.	-	832	-	9	978	64	1883
	N.D.B.	-	1968	-	2274	8971	598	13811
	Combined	-	2800	-	2283	9949	662	15694
1980	W.B.	-	747	-	-	1269	83	2099
	N.D.B.	-	913	-	727	2778	13	4431
	Combined	-	1660	-	727	4047	96	6530
1981	W.B.	-	220	-	14	646	23	903
	N.D.B.	-	1065	-	400	2209	107	3781
	Combined	-	1285	-	414	2855	130	4684
1982	W.B.	-	-	-	7	402	52	461
	N.D.B.	-	-	-	136	1425	1	1562
	Combined	-	-	-	143	1827	53	2023
1983	W.B.	-	15	-	-	76	7	98
	N.D.B.	-	-	-	-	329	-	329
	Combined	-	15	-	-	406	7	427
1984	W.B.	-	-	-	4	342	4	350
	N.D.B.	-	-	-	3	1115	-	1118
	Combined	-	-	-	7	1457	4	1468
1985	W.B.	-	-	-	2	564	-	566
	N.D.B.	1	-	-	9	1248	-	1258
	Combined	1	-	-	11	1812	-	1824
1986*	W.B.	112	-	-	1	196	7	316
	N.D.B.	1124	-	-	71	1108	81	2384
	Combined	1236	-	-	72	1304	88	2700
1987*	W.B.	4090	-	-	60	387	4	4541
	N.D.B.	7205	-	-	551	1031	645	9432
	Combined	11,295	-	-	611	1418	649	13,973
1988*	W.B.	1809	-	-	19	67	-	1895
	N.D.B.	4223	-	-	360	707	113	5403
	Combined	6032	-	-	379	774	113	7298

* provisional

Table 2. Bonavista Bay (B.B.) - Trinity Bay (T.B.) herring landings (t), by gear, 1974-88.

Year	Area	Gear						Total
		Purse seine	Ringnet	Midwater trawl	Bar seine	Gillnet	Trap	
1974	B.B.	-	-	-	21	611	10	642
	T.B.	-	428	-	154	976	93	1651
	Combined	-	428	-	175	1587	103	2293
1975	B.B.	1559	-	-	34	414	2	2009
	T.B.	1370	1790	-	242	411	90	3903
	Combined	2929	1790	-	276	825	92	5912
1976	B.B.	2812	3052	-	24	328	139	6355
	T.B.	1614	1054	-	465	419	30	3582
	Combined	4426	4106	-	489	747	169	9937
1977	B.B.	-	6223	236	2495	309	-	9263
	T.B.	-	1548	-	927	174	45	2694
	Combined	-	7771	236	3422	483	45	11,957
1978	B.B.	-	4239	-	150	1320	3	5712
	T.B.	-	1055	-	966	308	8	2337
	Combined	-	5294	-	1116	1628	11	8049
1979	B.B.	-	3490	-	377	2374	4	6245
	T.B.	-	1181	-	1615	680	55	3531
	Combined	-	4671	-	1992	3054	59	9776
1980	B.B.	-	1714	-	652	1321	-	3687
	T.B.	-	964	-	405	336	13	1718
	Combined	-	2678	-	1057	1657	13	5405
1981	B.B.	-	1100	-	713	1399	7	3219
	T.B.	-	78	-	361	367	19	825
	Combined	-	1178	-	1074	1766	26	4044
1982	B.B.	-	-	-	-	386	4	390
	T.B.	-	-	-	25	76	6	107
	Combined	-	-	-	25	462	10	497
1983	B.B.	-	-	-	-	52	-	52
	T.B.	-	-	-	27	17	-	44
	Combined	-	-	-	27	69	-	96
1984	B.B.	-	-	-	-	135	-	135
	T.B.	-	-	-	-	41	-	41
	Combined	-	-	-	-	176	-	176
1985	B.B.	-	-	-	4	290	2	296
	T.B.	-	-	-	2	312	6	320
	Combined	-	-	-	6	602	8	616
1986*	B.B	706	-	-	7	402	5	1120
	T.B.	347	-	-	35	215	5	602
	Combined	1053	-	-	42	617	10	1722
1987*	B.B	5404	-	-	72	226	-	5702
	T.B.	1006	-	-	14	186	1	1207
	Combined	6410	-	-	86	412	1	6909
1988	B.B.	5951	-	-	280	172	-	6403
	T.B.	3207	-	-	273	94	85	3659
	Combined	9158	-	-	553	266	85	10062

* provisional

Table 3. Conception Bay (C.B.)- Southern Shore (S.S.) herring landings (t), by gear, 1974-88.

Year	Area	Gear						Total
		Purse seine	Ringnet	Midwater trawl	Bar seine	Gillnet	Trap	
1974	C.B.	48	2107	-	67	131	134	2487
	S.S.	-	32	-	14	72	86	204
	Combined	48	2139	-	81	203	220	2691
1975	C.B.	13	2281	-	388	166	24	2872
	S.S.	315	-	-	23	160	169	667
	Combined	328	2281	-	411	326	193	3539
1976	C.B.	-	1704	258	76	153	92	2283
	S.S.	-	44	-	-	8	149	201
	Combined	-	1748	258	76	161	241	2484
1977	C.B.	-	1248	-	58	174	12	1492
	S.S.	-	442	-	-	18	200	660
	Combined	-	1690	-	58	192	212	2152
1978	C.B.	-	1098	-	11	415	3	1527
	S.S.	-	133	-	14	78	193	418
	Combined	-	1231	-	25	493	196	1945
1979	C.B.	-	432	-	-	210	63	705
	S.S.	-	10	-	18	49	111	188
	Combined	-	442	-	18	259	174	893
1980	C.B.	-	319	-	16	107	1	443
	S.S.	-	-	-	-	2	32	34
	Combined	-	319	-	16	109	33	477
1981	C.B.	-	-	-	-	160	2	162
	S.S.	-	-	-	-	53	8	61
	Combined	-	-	-	-	213	10	223
1982	C.B.	-	-	-	-	84	1	85
	S.S.	-	-	-	-	7	5	12
	Combined	-	-	-	-	91	6	97
1983	C.B.	-	-	-	-	17	-	17
	S.S.	-	-	-	-	-	-	-
	Combined	-	-	-	-	17	-	17
1984	C.B.	-	-	-	-	49	-	49
	S.S.	-	-	-	-	-	-	-
	Combined	-	-	-	-	49	-	49
1985	C.B.	-	-	-	-	81	-	81
	S.S.	-	-	-	-	16	-	16
	Combined	-	-	-	-	97	-	97
1986*	C.B.	62	-	-	-	102	1	165
	S.S.	-	-	-	1	23	1	25
	Combined	62	-	-	1	125	2	190
1987*	C.B.	727	-	15	324	239	10	1315
	S.S.	-	-	-	-	15	3	18
	Combined	727	-	15	324	254	13	1333
1988*	C.B.	414	-	-	1	35	2	452
	S.S.	1	-	-	-	8	72	81
	Combined	415	-	-	1	45	74	533

* provisional

Table 4. St. Mary's Bay (SMB)-Placentia Bay (PB) herring landings (t), by gear, 1974–88.

Year	Area	Gear					Total
		Purse seine	Ringnet	Bar seine	Gillnet	Trap	
1974	S.M.B.	1710	51	271	470	37	2539
	P.B.	3200	–	212	510	11	3933
	Combined	4910	51	483	980	48	6472
1975	S.M.B.	1032	711	554	674	243	3214
	P.B.	2638	–	225	450	188	3501
	Combined	3670	711	779	1124	431	6715
1976	S.M.B.	–	920	158	352	25	1455
	P.B.	2056	172	242	177	–	2647
	Combined	2056	1092	400	529	25	4102
1977	S.M.B.	–	1131	221	531	29	1912
	P.B.	740	524	14	78	–	1356
	Combined	740	1655	235	609	29	3268
1978	S.M.B.	–	1523	66	490	3	2082
	P.B.	557	612	29	214	33	1445
	Combined	557	2135	95	704	36	3527
1979	S.M.B.	–	1570	131	332	9	2042
	P.B.	359	891	17	307	1	1575
	Combined	359	2461	148	639	10	3617
1980	S.M.B.	–	645	16	352	12	1025
	P.B.	182	892	9	339	30	1452
	Combined	182	1537	25	691	42	2477
1981	S.M.B.	–	44	8	122	–	174
	P.B.	–	311	–	149	1	461
	Combined	–	355	8	271	1	635
1982	S.M.B.	–	–	–	10	–	10
	P.B.	–	–	4	31	–	35
	Combined	–	–	4	41	–	45
1983	S.M.B.	–	–	–	13	–	13
	P.B.	–	–	–	27	–	27
	Combined	–	–	–	40	–	40
1984	S.M.B.	–	–	–	11	–	11
	P.B.	–	–	1	95	–	96
	Combined	–	–	1	106	–	107
1985	S.M.B.	–	–	1	31	–	32
	P.B.	3	–	–	113	–	116
	Combined	3	–	1	144	–	148
1986*	S.M.B.	1	–	–	17	–	18
	P.B.	–	–	2	107	–	109
	Combined	1	–	2	124	–	127
1987*	S.M.B.	43	–	5	47	5	100
	P.B.	–	–	1	160	–	161
	Combined	43	–	6	207	5	261
1988*	S.M.B.	–	–	–	25	–	25
	P.B.	1020	–	8	177	–	1205
	Combined	1020	–	8	202	–	1230

* provisional

Table 5. Fortune Bay herring landings (t), by gear, 1974-88.

Year	Gear				Total
	Purse seine	Bar seine	Gillnet	Trap	
1974	1928	268	72	-	2268
1975	809	81	19	-	909
1976	109	310	43	-	462
1977	188	364	22	5	579
1978	104	854	41	-	999
1979	285	829	81	-	1195
1980	97	265	89	-	451
1981	-	30	37	-	67
1982	-	-	20	2	22
1983	-	-	15	-	15
1984	-	-	21	-	21
1985	-	-	52	-	52
1986*	1	1	91	-	93
1987*	-	2	144	-	146
1988*	2	2	86	-	90

* provisional

Table 6. Number of fish sampled from the Newfoundland herring fishery, by area and gear, 1983–88 (research samples in parenthesis).

Year	Area	Gear type: Trap	Bar seine	Gillnet	Ringnet	Total sampled	Comm. catch (t)
1983	WB	–	63	376 (799)	22	461 (799)	98
	NDB	–	–	(1230)	200 (2927)	200 (4157)	329
	BB	700	–	645 (1210)	(2056)	1345 (3275)	52
	TB	527	–	548 (678)	(700)	1075 (1378)	44
	CB	326	–	50 (145)	(450)	376 (595)	17
	SS	150	–	–	–	150	–
	SMB	–	–	(659)	798	798 (659)	13
	PB	100	–	(605)	–	100 (605)	27
	FB	–	–	(1017)	–	(1017)	15
	Total	1803	63	1619 (6343)	1020 (6142)	4505 (12485)	595
1984	WB	121	–	825 (1207)	–	946 (1207)	350
	NDB	–	50	2116 (1150)	(664)	2166 (1814)	1118
	BB	–	–	550 (1860)	(844)	550 (2704)	135
	TB	150	(100)	200 (800)	(700)	350 (1600)	41
	CB	(100)	–	50 (400)	(464)	50 (964)	49
	SS	–	–	–	–	–	–
	SMB	–	–	(1110)	223	223 (1110)	11
	PB	98	–	488 (653)	(136)	586 (789)	96
	FB	–	–	4666 (612)	(182)	466 (794)	21
	Total	369 (100)	50 (100)	4695 (7792)	223 (2990)	5337 (10982)	1821
1985	WB	175	–	580 (1047)	–	755 (1047)	566
	NDB	–	100	994 (1200)	(237)	1094 (1437)	1258
	BB	–	–	1048 (2036)	(350)	1048 (2386)	296
	TB	–	–	536 (1000)	(317)	536 (1317)	320
	CB	26	–	450 (800)	(150)	476 (950)	81
	SS	–	–	100 (500)	–	100 (500)	16
	SMB	–	–	50 (598)	50	100 (598)	32
	PB	–	–	92 (697)	50	142 (697)	116
	FB	–	–	500 (900)	(250)	500 (1150)	52
	Total	201	100	4350 (8778)	100 (1304)	4751 (10082)	2737
1986	WB	–	–	(1150)	100	100 (1150)	316
	NDB	77	50	600 (1222)	50 (400)	777 (1622)	2384
	BB	150	–	400 (1949)	389 (150)	939 (2099)	1120
	TB	150	100	400 (800)	150 (700)	800 (1500)	602
	CB	150 (236)	–	344 (1010)	(100)	494 (1346)	165
	SS	–	–	(579)	–	(579)	25
	SMB	50	–	100 (850)	150	300 (850)	18
	PB	50	–	582 (558)	(350)	632 (908)	109
	FB	–	–	286 (1338)	(100)	286 (1438)	93
	Total	627 (236)	150	2712 (9456)	839 (1800)	4328 (11492)	4832
1987	WB	–	–	350 (850)	246	596 (850)	4541
	NDB	250	–	300 (1174)	583 (313)	1133 (1487)	9432
	BB	50	–	265 (1592)	546 (169)	861 (1761)	5703
	TB	–	100	196 (1100)	386 (50)	682 (1150)	1208
	CB	50 (200)	–	150 (500)	200	400 (700)	1314
	SS	50	–	95 (250)	–	145 (250)	18
	SMB	–	50 (200)	50 (800)	50	150 (1000)	99
	PB	–	–	200 (786)	–	200 (786)	161
	FB	–	–	191 (1300)	–	191 (1300)	145
	Total	400 (200)	150 (200)	1797 (8352)	2011 (532)	4358 (9284)	22621
1988	WB	–	–	50 (1229)	200	250 (1229)	1895
	NDB	46	–	349 (1817)	300 (600)	695 (2417)	5403
	BB	–	–	297 (2320)	400	697 (2320)	6403
	TB	100	100	200 (1100)	300	700 (1100)	3659
	CB	50	–	178 (1213)	141	369 (1213)	452
	SS	94	–	– (377)	–	94 (377)	81
	SMB	–	–	98 (731)	48	146 (731)	26
	PB	–	–	134 (846)	136	270 (846)	1204
	FB	–	–	194 (1246)	–	194 (1246	90
	Total	290	100	1500 (10879)	1525 (600)	3415 (11479)	19213

Table 7. Commercial catch (t) and sampling (number of fish) for 1988, by stock area, month, and gear type.

		WB-NDB		BB-TB		CB-SS		SMB-PB		FB	
Month	Gear	Catch	# Sampled	Catch	# Sampled	Catch	# Sampled	Catch	# Sampled	Catch	# Sampled
January	Gillnet	–	–	–	–	–	–	1	–	1	–
	Bar seine	–	–	–	–	–	–	–	–	1	–
	Purse seine	–	–	74	–	–	–	237	50	–	–
February	Purse seine	–	–	–	–	–	–	–	–	1	–
March	Gillnet	1	–	2	–	–	–	5	–	4	47
	Purse seine	–	–	387	50	159	41	507	50	–	–
April	Gillnet	34	–	10	50	2	43	103	390	32	375
	Trap	–	–	13	–	4	49	–	–	–	–
	Bar seine	–	–	1	–	–	–	–	–	–	–
	Purse seine	–	–	431	100	1	–	26	36	–	–
May	Gillnet	469	308	113	585	24	490	75	659	31	432
	Trap	59	–	3	50	24	45	–	–	–	–
	Bar seine	262	–	284	100	–	–	7	–	–	–
	Purse seine	664	100	659	–	–	–	129	–	1	–
June	Gillnet	131	243	16	152	11	18	17	–	15	–
	Trap	11	–	38	50	39	–	–	–	–	–
	Bar seine	40	–	51	–	–	–	–	–	–	–
	Purse seine	146	100	5	–	–	–	69	48	–	–
July	Gillnet	33	186	1	19	1	–	–	–	1	–
	Trap	–	–	–	–	4	–	–	–	–	–
	Bar seine	1	–	23	–	–	–	–	–	–	–
August	Gillnet	12	183	3	62	1	–	1	43	1	–
	Trap	22	–	17	–	2	50	–	–	–	–
	Bar seine	–	–	48	–	–	–	–	–	–	–
	Purse seine	237	100	59	50	–	–	–	–	–	–
September	Gillnet	32	122	5	50	2	50	–	–	1	48
	Trap	19	46	5	–	–	–	–	–	–	–
	Bar seine	–	–	8	–	–	–	–	–	–	–
	Purse seine	483	150	4	–	14	–	–	–	–	–
October	Gillnet	56	846	28	844	2	337	–	–	1	–
	Trap	–	–	9	–	–	–	–	–	–	–
	Bar seine	–	–	19	–	1	–	–	–	–	–
	Purse seine	2773	150	1833	250	7	–	12	–	–	–
November	Gillnet	6	71	57	410	1	73	–	–	–	–
	Trap	2	–	–	–	–	–	–	–	–	–
	Bar seine	–	–	24	–	–	–	–	–	–	–
	Purse seine	695	450	1389	150	235	–	39	–	–	–
December	Gillnet	–	–	29	25	–	–	–	–	1	50
	Trap	–	–	–	–	1	–	–	–	–	–
	Bar seine	75	–	96	–	–	–	–	–	–	–
	Purse seine	1034	50	4315	150	–	100	–	–	–	–
Combined	Gillnet	775	1959	264	2197	44	1011	202	1092	88	952
	Trap	113	46	85	100	74	144	–	–	–	–
	Bar seine	378	–	554	100	1	–	7	–	1	–
	Purse seine	6032	1100	9156	750	416	141	1019	184	2	–

Table 8. Mean weight at age (g) of Newfoundland spring spawning herring from samples collected January-June, 1988. Sample sizes in parenthesis.

Age	Stock area				
	WB-NDB	BB-TB	CB-SS	SMB-PB	FB
0	-	-	-	-	-
1	-	-	-	14 (1)	-
2	81 (5)	83 (5)	69 (6)	120 (4)	-
3	148 (40)	129 (207)	149 (34)	164 (29)	-
4	214 (22)	196 (17)	232 (19)	232 (33)	-
5	235 (207)	233 (91)	248 (37)	261 (32)	236 (5)
6	256 (519)	255 (1049)	269 (665)	285 (1111)	275 (932)
7	295 (42)	285 (20)	284 (25)	305 (58)	295 (26)
8	316 (57)	318 (24)	313 (41)	320 (188)	331 (130)
9	323 (102)	358 (19)	346 (7)	330 (28)	353 (38)
10	333 (12)	-	346 (2)	350 (6)	390 (6)
11+	414 (217)	421 (281)	425 (87)	419 (92)	462 (58)

Table 9. Commercial catch at age of spring and autumn spawning herring for White Bay-Notre Dame Bay, 1970-88.

	Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Spring spawners	1	1	1	1	1	1	1	1	1	1	1	1
	2	10	1	5	1	1	2	56	50	1	1	115
	3	1	129	290	727	4	128	24	1671	55	60	46
	4	12	88	2396	1411	123	215	506	107	2034	50	1240
	5	24	161	353	2825	3142	453	237	468	317	2928	92
	6	24	64	69	761	5446	5438	868	184	1034	323	1080
	7	972	425	122	719	1193	7069	10893	793	517	1410	17
	8	11	10184	403	654	697	1123	17145	7363	2509	767	496
	9	83	233	1363	416	1506	838	1328	12675	10807	2222	179
	10	159	254	205	1685	858	810	3364	1055	11756	14413	1450
	11+	275	3105	808	794	2378	3999	8535	15707	14379	27508	14653
Total SS		1572	14645	6015	9995	15349	20076	42957	40074	43410	49683	19369
Autumn spawners	1	1	1	1	1	1	1	1	1	1	1	1
	2	1	1	1	1	1	1	1	1	1	1	1
	3	1	1	53	1	1	6	1	1	1	1	71
	4	1	1	17	7	11	64	31	45	6	1	13
	5	26	6	74	22	124	3	35	35	24	10	13
	6	10	14	79	25	10	25	51	85	155	267	23
	7	39	11	67	60	48	16	20	54	171	172	272
	8	60	26	1	25	2	21	40	1	24	160	4
	9	20	17	164	13	46	3	46	94	2	133	19
	10	11	19	81	97	7	2	4	1	130	1	1
	11+	172	291	562	298	346	302	329	182	238	298	450
Total AS		342	388	1100	550	597	444	559	500	753	1045	868
Total AS & SS		1914	15033	7115	10545	15946	20520	43516	40572	44163	50728	20237
% SS		82.1	97.4	84.5	94.8	96.3	97.8	98.7	98.8	98.3	97.9	95.7
% AS		17.9	2.6	15.5	5.2	3.7	2.2	1.3	1.2	1.7	2.1	4.3

	Age	1981	1982	1983	1984	1985	1986*	1987*	1988*
Spring spawners	1	1	1	1	1	1	1	23	2848
	2	445	76	1	6	3	26	999	401
	3	152	371	38	12	187	947	412	1074
	4	41	332	46	124	350	2843	7709	299
	5	1231	59	23	1218	240	302	27152	2939
	6	63	268	14	73	1486	661	1600	11655
	7	805	34	93	114	108	1236	1028	1012
	8	64	258	1	157	275	198	2024	1128
	9	344	19	26	37	94	161	380	1422
	10	194	192	4	122	81	177	517	315
	11+	10908	4059	805	1938	2110	1951	4692	2840
Total SS		14248	5669	1052	3802	4935	8503	46536**	25933***
Autumn spawners	1	1	1	1	1	1	1	1	1
	2	1	1	1	1	1	1	1	1
	3	1	72	1	1	1	10	2	1
	4	13	26	74	60	29	66	290	97
	5	86	62	25	409	94	68	552	111
	6	11	16	23	66	333	76	156	44
	7	1	12	1	30	137	372	205	20
	8	100	9	1	8	32	68	628	7
	9	1	42	6	7	23	6	148	578
	10	4	1	1	3	10	1	10	6
	11+	65	23	1	24	74	39	104	303
Total AS		284	265	135	610	735	708	2097	1169
Total AS & SS		14532	5934	1187	4412	5670	9211	48633	27102
% SS		98.0	95.5	88.6	86.2	87.0	92.3	95.7	95.7
% AS		2.0	4.5	11.4	13.8	13.0	7.7	4.3	4.3

* preliminary
** 4242 age 0's in 1987 SS not included
*** 10 age 0's in 1988 SS not included

Table 10. Commercial catch at age of spring and autumn spawning herring for Bonavista Bay–Trinity Bay, 1970–88.

	Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Spring	1	1	1	1	1	1	1	5	10	1	1	1
spawners	2	1	1	1	1	1	1	14	16	22	6	15
	3	1	690	10	1	1	392	77	248	26	286	13
	4	1	311	1347	60	2	134	493	135	357	167	195
	5	9	102	389	4887	235	163	123	759	122	765	43
	6	55	64	91	126	4795	2564	166	227	251	19	293
	7	808	361	75	96	424	14330	4897	50	112	436	52
	8	35	1373	88	1	151	455	20697	6209	598	101	264
	9	126	151	480	48	294	995	909	23206	4412	530	75
	10	69	126	14	271	69	727	854	774	13394	5575	967
	11+	212	522	213	1	1849	1679	4306	5890	5956	19994	12259
Total SS		1318	3702	2709	5488	7822	21441	32539	37524	25251	27880	14177
Autumn	1	1	1	1	1	1	1	1	1	1	1	1
spawners	2	1	1	1	1	1	1	1	1	1	1	1
	3	1	1	1	1	1	1	10	1	1	1	14
	4	9	1	1	1	1	26	22	55	16	1	11
	5	1	10	1	1	1	30	77	16	14	27	17
	6	1	1	1	1	1	1	23	176	61	114	83
	7	4	4	2	1	16	22	66	86	58	30	188
	8	17	23	2	48	2	41	34	112	28	175	45
	9	18	3	5	1	1	6	62	30	23	13	112
	10	17	21	1	1	1	19	8	73	82	16	3
	11+	738	406	33	1	1216	259	1069	1069	417	800	463
Total AS		808	472	49	58	1242	407	1373	1620	702	1179	938
Total AS & SS		2126	4174	2758	5546	9064	21848	33912	39114	25953	29059	15115
% SS		62.0	88.7	98.2	99.0	86.3	98.1	96.0	95.9	97.3	95.9	93.8
% AS	38.0	11.3	1.8	1.0	13.7	1.9	4.0	4.1	2.7	4.1	6.2	

	Age	1981	1982	1983	1984	1985	1986*	1987*	1988*
Spring	1	1	1	1	1	1	141	394	267
spawners	2	136	1	1	4	13	190	1424	2923
	3	246	8	4	22	175	397	576	8190
	4	53	11	34	35	70	4163	3084	185
	5	256	2	7	210	87	253	18732	3037
	6	26	30	2	9	351	162	397	20858
	7	288	5	15	5	37	262	441	853
	8	23	35	1	12	27	39	89	811
	9	321	5	8	2	13	10	43	8
	10	88	65	2	2	22	31	6	27
	11+	11762	1186	159	154	797	635	919	802
Total SS		13200	1349	234	456	1593**	6283	26105***	37961
Autumn	1	1	1	1	1	1	1	15	1
spawners	2	1	1	1	1	1	1	1	97
	3	6	3	1	1	1	1	1	26
	4	115	1	10	3	5	50	2	15
	5	106	8	2	84	18	81	508	73
	6	33	10	5	14	203	58	268	398
	7	83	3	2	17	96	277	78	177
	8	283	8	1	3	54	150	439	156
	9	36	25	1	5	22	25	124	673
	10	4	1	1	1	10	1	3	2
	11+	230	37	3	9	29	30	201	192
Total AS		898	98	28	139	440	675	1640	1810
Total AS & SS		14098	1447	262	595	2033	6958	27745	39771
% SS		93.6	93.2	89.3	76.6	78.4	90.3	94.1	95.4
% AS		6.4	6.8	10.7	23.4	21.6	9.7	5.9	4.6

* preliminary
** 10 age 0's in 1985 SS not included
*** 2396 age 0's in 1987 SS not included

Table 11. Commercial catch at age of spring and autumn spawning herring for Conception Bay-Southern, 1970-88.

	Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Spring spawners	1	1	1	1	1	1	1	1	1	1	1	1
	2	1	1	1	67	4	9	1177	7	1	1	1
	3	1	36	7	2	1	418	28	127	1	4	1
	4	15	31	1625	34	5	30	97	5	99	9	3
	5	17	19	134	4521	122	16	23	101	32	34	1
	6	21	11	55	242	9655	2057	31	45	65	7	19
	7	255	43	29	329	153	8592	2330	13	14	38	1
	8	12	272	79	142	83	120	4771	950	3	4	12
	9	13	26	361	44	39	517	89	4241	734	31	1
	10	11	11	67	175	13	238	252	49	3080	270	49
	11+	46	65	122	28	658	891	714	959	1358	1640	1101
Total SS		393	516	2481	5585	10734	12889	9513	6498	5388	2039	1190
Autumn spawners	1	1	1	1	1	1	1	1	1	1	1	1
	2	1	1	1	1	1	1	1	1	1	1	1
	3	1	1	1	1	2	7	1	1	1	1	1
	4	1	1	1	2	3	162	1	7	4	2	1
	5	1	1	1	2	8	40	49	29	50	17	1
	6	8	1	1	1	6	81	27	150	30	80	1
	7	20	1	1	38	17	18	23	87	69	15	32
	8	36	6	1	35	1	49	23	72	9	57	3
	9	5	34	1	1	6	11	31	13	10	17	6
	10	6	11	1	1	1	14	12	7	34	6	1
	11+	114	89	1	94	45	318	193	373	282	245	32
Total AS		194	147	11	177	91	702	362	741	491	442	80
Total AS & SS		587	663	2492	5762	10825	13591	9875	7239	5879	2481	1270
% SS		67.0	77.8	99.6	96.9	99.2	94.8	93.6	89.8	91.6	82.2	93.7
% AS		33.0	22.2	0.4	3.1	0.8	5.2	3.7	10.2	8.4	17.8	6.3

	Age	1981	1982	1983	1984	1985	1986*	1987*	1988*
Spring spawners	1	1	1	1	1	1	1	714	22
	2	1	1	1	1	1	5	1	2
	3	25	2	1	3	58	1	66	175
	4	4	5	1	27	11	346	135	47
	5	26	1	1	47	11	7	4914	518
	6	9	2	1	5	17	12	19	966
	7	28	1	1	1	2	16	28	99
	8	3	5	1	2	2	3	14	48
	9	14	1	1	1	1	1	3	4
	10	13	1	1	1	1	3	1	1
	11+	504	176	13	7	97	80	61	89
Total SS		628	196	23	96	202	475	5956	1971
Autumn spawners	1	1	1	1	1	1	1	1	1
	2	1	1	1	1	1	1	1	1
	3	1	9	1	1	1	19	1	1
	4	14	5	1	4	3	6	5	1
	5	8	14	2	60	6	18	29	49
	6	3	1	3	6	52	21	27	141
	7	7	1	1	6	24	93	27	112
	8	14	2	2	3	13	29	30	61
	9	2	2	5	1	3	10	22	42
	10	1	1	1	1	1	3	9	1
	11+	9	5	12	1	15	10	6	1
Total AS		61	42	30	85	120	211	158	411
Total AS & SS		689	238	53	181	322	686	6114	2382
% SS		91.1	82.4	43.4	53.0	62.7	69.2	97.4	82.7
% AS		8.9	17.6	56.6	47.0	37.3	30.8	2.6	17.1

* preliminary

Table 12. Commercial catch at age of spring and autumn spawning herring for St. Mary's Bay-Placentia Bay, 1970-88.

	Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Spring	1	3	1	1	1	3	1	1	1	1	1	1
spawners	2	476	1	1	76	995	74	365	52	30	87	133
	3	109	557	207	326	280	2234	391	1423	175	663	332
	4	4434	116	20375	77	234	471	1906	140	1817	279	133
	5	59	2111	725	15470	126	147	208	736	123	2263	153
	6	76	80	5154	566	14328	1591	267	87	596	96	1270
	7	645	251	365	6757	436	13858	862	50	64	614	57
	8	66	45	650	93	6049	146	5622	1039	106	85	470
	9	72	13	352	224	138	3391	201	3830	512	66	38
	10	37	22	73	193	238	350	2256	134	3827	501	237
	11+	107	96	403	315	624	1323	1361	2448	2185	4785	2971
Total SS		6084	3293	28306	24098	23451	23586	13440	9940	9436	9440	5795
Autumn	1	1	1	1	1	1	1	1	1	1	1	1
spawners	2	1	1	1	1	1	1	1	1	1	1	1
	3	1	1	24	5	2	1	11	1	1	1	1
	4	1	9	61	150	2	7	4	47	23	11	96
	5	2	2	175	52	96	68	214	52	435	143	35
	6	1	53	15	71	146	182	67	209	92	598	52
	7	71	31	61	10	80	89	32	81	244	73	419
	8	112	43	37	54	95	206	17	69	122	216	79
	9	19	84	101	17	93	6	94	26	38	21	126
	10	28	35	71	68	51	37	11	22	52	2	25
	11+	202	314	539	737	970	677	329	526	561	348	492
Total AS		439	574	1086	1166	1537	1275	781	1035	1570	1415	1327
Total AS & SS		6523	3867	29392	25264	24988	24861	14221	10975	11006	10855	7122
% SS		93.3	85.2	96.3	95.4	93.8	94.9	94.5	90.6	85.7	87.0	81.4
% AS		6.7	14.8	3.7	4.6	6.2	5.1	5.5	9.4	14.3	13.0	18.6

	Age	1981	1982	1983	1984	1985	1986*	1987*	1988*
Spring	1	1	1	1	1	1	1	1	1
spawners	2	1	1	1	8	1	1	35	1
	3	193	1	5	9	7	1	23	1
	4	42	2	2	24	18	132	2	30
	5	111	3	3	36	27	19	524	205
	6	51	8	2	6	21	27	29	2723
	7	338	3	4	3	15	9	48	139
	8	28	14	1	24	3	4	9	282
	9	80	4	9	1	25	1	3	16
	10	6	4	1	10	5	5	1	53
	11+	466	69	39	44	125	30	11	167
Total SS		1317	110	68	166	248	230	686	3618
Autumn	1	1	1	1	1	1	1	1	1
spawners	2	1	1	1	1	1	1	2	1
	3	1	1	1	1	1	1	4	1
	4	139	1	18	17	9	16	12	28
	5	116	7	6	101	20	24	33	25
	6	10	1	12	32	86	15	86	236
	7	11	1	4	21	46	96	31	74
	8	50	1	1	5	36	28	85	29
	9	7	1	1	3	10	16	24	295
	10	1	1	1	1	3	4	3	5
	11+	29	2	4	8	24	15	12	70
Total AS		366	18	50	191	237	217	293	765
Total AS & SS		1683	128	118	357	485	447	979	4383
% SS		78.3	85.9	57.6	46.5	51.1	51.5	70.1	82.5
% AS		21.7	14.1	42.4	53.5	48.9	48.5	29.9	17.5

* preliminary

Table 13. Commercial catch at age of spring and autumn spawning herring for Fortune Bay, 1970-88.

	Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Spring	1	1	1	617	23	1	1	1	1	1	1	1
spawners	2	29475	167	1515	2210	389	2	82	27	1	1	25
	3	5988	23223	256	925	1314	277	15	2103	42	1	16
	4	11953	6086	19690	67	552	581	318	25	2677	183	3
	5	133	23525	2896	5694	130	112	228	327	62	3833	69
	6	281	1165	10767	475	4435	87	129	166	237	15	1122
	7	7894	5747	351	1712	250	1490	11	26	43	165	7
	8	233	3514	4432	73	1094	16	338	43	139	5	183
	9	16	132	991	282	36	142	36	188	52	24	1
	10	225	148	34	558	117	22	188	4	326	1	11
	11+	257	537	366	173	255	201	140	244	302	167	50
Total SS		56456	64245	41915	12192	8573	2931	1486	3154	3882	4396	1488
Autumn	1	1	1	1	1	1	1	1	1	1	1	1
spawners	2	1	1	1	1	1	1	1	1	1	1	1
	3	1	1	1	1	7	1	7	1	1	1	1
	4	1	598	1	48	9	22	9	23	1	7	4
	5	334	1	84	50	87	12	38	19	36	5	3
	6	1	136	25	79	65	39	26	19	6	50	3
	7	443	175	185	8	12	19	13	1	25	1	3
	8	816	769	44	32	27	20	1	1	12	17	1
	9	412	626	310	15	5	11	27	1	6	12	1
	10	1	470	125	27	1	7	1	1	1	1	1
	11+	2201	1956	793	97	85	45	9	2	18	12	1
Total AS		4212	4734	1570	359	300	178	133	70	108	108	20
Total AS & SS		60668	68979	43485	12551	8873	3109	1619	3224	3990	4504	1508
% SS		93.1	93.1	96.4	97.1	96.6	94.3	91.8	97.8	97.3	97.6	98.7
% AS		6.9	6.9	3.6	2.9	3.4	5.7	8.2	2.2	2.7	2.4	1.3

	Age	1981	1982	1983	1984	1985	1986*	1987*	1988*
Spring	1	1	1	1	1	1	1	1	1
spawners	2	1	1	1	2	1	1	1	1
	3	144	1	2	1	54	1	1	1
	4	16	3	2	4	3	137	1	1
	5	4	3	1	3	39	4	304	1
	6	3	1	1	2	12	68	11	225
	7	21	2	1	1	2	19	49	7
	8	2	36	1	2	1	5	18	27
	9	23	1	10	1	1	1	4	6
	10	1	5	1	2	1	2	1	1
	11+	12	5	18	23	15	13	38	10
Total SS		228	59	39	42	130	252	429	281
Autumn	1	1	1	1	1	1	1	1	1
spawners	2	1	1	1	1	1	1	1	1
	3	5	1	1	1	1	1	1	1
	4	64	1	1	1	17	3	1	2
	5	16	7	1	9	4	8	4	1
	6	1	2	2	4	26	16	7	5
	7	1	1	1	6	12	38	11	5
	8	1	1	1	1	7	12	25	1
	9	1	1	1	1	4	5	10	13
	10	1	1	1	1	1	1	5	1
	11+	1	1	1	1	2	5	14	11
Total AS		93	18	12	27	76	91	80	42
Total AS & SS		321	77	51	69	206	343	509	323
% SS		71.0	76.6	76.5	60.9	63.1	73.5	84.3	87.0
% AS		29.0	23.4	23.5	39.1	36.9	26.5	15.7	13.0

* preliminary

Table 14. Catch rates at age (numbers of herring) by area and season calculated from catch/effort data and biological samples for the research gillnet program (* adjusted to account for shallow nets).

Autumn spawners

Area	Season	Age	1980*	1981*	1982*	1983	1984	1985	1986	1987	1988
WB-NDB	Fall	1	-	-	-	-	-	-	-	-	-
		2	-	-	-	-	-	-	-	-	0.2
		3	3.3	0.2	6.9	-	14.0	-	-	-	0.1
		4	0.4	0.8	3.4	14.1	2.1	1.5	2.9	15.7	2.2
		5	1.5	-	3.8	1.6	40.9	1.5	3.9	20.3	3.2
		6	1.8	0.3	3.3	4.2	10.2	13.8	3.3	15.1	1.5
		7	1.8	-	-	1.4	1.3	7.5	10.2	2.8	0.8
		8	0.1	0.2	-	0.2	1.1	-	2.6	8.5	0.4
		9	0.2	-	1.5	0.3	0.3	-	0.4	2.9	1.7
		10	-	-	-	0.9	0.2	-	-	2.1	0.4
		11+	4.3	0.2	0.4	1.9	3.3	2.3	1.3	1.1	1.0
		Total	13.4	1.7	19.3	24.6	73.4	26.6	24.6	68.5	12.5

Spring spawners

	1980*	1981*	1982*	1983	1984	1985	1986	1987	1988
1	-	-	-	-	-	-	-	-	0.3
2	9.8	4.5	8.5	0.4	23.3	2.7	0.2	1.4	5.7
3	8.3	5.2	29.2	49.8	6.4	134.6	9.0	0.4	3.9
4	203.8	1.1	5.6	81.2	19.1	18.9	107.4	38.8	3.6
5	6.9	25.3	3.4	7.4	84.0	11.6	12.6	351.8	17.9
6	92.1	1.0	1.9	14.2	4.3	60.1	9.0	35.1	90.3
7	2.6	5.3	0.8	20.0	8.5	6.9	38.3	15.8	7.9
8	29.1	0.5	9.2	2.4	14.1	6.8	3.7	57.1	6.6
9	4.4	2.0	-	22.4	1.0	7.4	2.5	8.5	13.4
10	33.8	0.8	15.6	5.2	8.4	5.2	3.0	5.3	1.3
11+	504.2	83.9	192.8	318.7	254.9	119.4	50.2	102.1	27.0
Total	895.0	129.6	267.0	521.7	424.0	373.6	235.9	616.3	177.9

Autumn and spring spawners combined

	1980*	1981*	1982*	1983	1984	1985	1986	1987	1988
1	-	-	-	-	-	-	-	-	0.3
2	9.8	4.5	8.5	0.4	23.3	2.7	0.2	1.4	5.9
3	11.6	5.5	36.1	49.9	20.3	134.6	9.0	0.4	4.0
4	204.2	2.0	9.0	95.4	21.1	20.4	110.3	54.6	5.8
5	8.4	25.4	7.2	9.0	124.9	13.1	16.4	372.1	21.2
6	93.9	1.4	5.3	18.4	14.6	74.0	12.3	50.2	91.8
7	4.4	5.4	0.9	21.3	9.7	14.3	48.6	18.6	8.7
8	29.2	0.7	9.3	2.6	15.2	6.8	6.4	65.6	7.0
9	4.5	2.0	1.5	22.7	1.3	7.5	2.8	11.4	15.1
10	33.8	0.8	15.6	6.1	8.7	5.3	3.0	7.4	1.7
11+	508.5	84.1	193.1	320.6	258.3	121.7	51.5	103.2	28.0
Total	908.3	131.8	286.5	546.4	497.4	400.4	260.5	684.9	189.5

Table 15. Catch rates at age (numbers of herring) by area and season calculated from catch/effort data and biological samples for the research gillnet program.

Autumn spawners

Area	Season	Age	1988	19__	19__	19__	19__	19__	19__	19__	19__
WB-NDB	Spring	1	-								
		2	-								
		3	-								
		4	-								
		5	0.8								
		6	1.4								
		7	0.8								
		8	0.7								
		9	4.9								
		10	0.1								
		11+	1.5								
		Total	10.2								

Spring spawners

	1988	19__	19__	19__	19__	19__	19__	19__	19__
1	-								
2	-								
3	5.0								
4	2.0								
5	23.8								
6	63.9								
7	5.9								
8	5.1								
9	12.9								
10	1.9								
11+	36.5								
Total	157.0								

Autumn and spring spawners combined

	1988	19__	198__	19__	19__	19__	19__	19__	19__
1	-								
2	-								
3	5.0								
4	2.0								
5	24.6								
6	65.3								
7	6.7								
8	5.9								
9	17.8								
10	2.0								
11+	38.0								
Total	167.1								

Table 16. Catch rates at age (numbers of herring) by area and season calculated from catch/effort data and biological samples for the research gillnet program (* adjusted to account for shallow nets).

Autumn spawners

Area	Season	Age	1980*	1981*	1982*	1983	1984	1985	1986	1987	1988
BB-TB	Fall	1	-	-	-	-	-	-	-	-	-
		2	-	-	-	-	-	-	-	-	0.2
		3	0.8	-	25.8	0.2	0.4	0.4	0.2	-	0.1
		4	1.2	1.8	4.0	33.6	1.2	0.9	0.7	0.3	0.5
		5	0.5	0.3	13.4	8.5	23.3	0.8	2.4	0.7	0.9
		6	1.2	0.2	0.4	10.0	5.0	8.8	2.8	0.7	1.2
		7	2.5	0.2	2.3	2.3	4.9	3.8	7.7	0.5	0.7
		8	0.6	3.2	0.1	1.5	0.5	0.8	2.0	2.7	0.1
		9	0.3	-	6.5	0.6	1.9	0.3	1.3	0.7	1.4
		10	-	-	-	4.4	-	-	0.1	0.1	0.5
		11+	2.0	1.6	6.9	4.5	4.4	1.2	1.0	0.6	1.8
		Total	8.5	7.4	59.6	65.5	41.6	17.0	18.1	6.4	7.2

Spring spawners

	1980*	1981*	1982*	1983	1984	1985	1986	1987	1988
1	-	-	-	-	-	-	-	-	0.7
2	20.6	1.7	6.4	0.9	18.1	2.2	2.4	3.7	5.3
3	1.3	2.5	91.5	8.2	7.6	50.3	5.8	0.3	15.7
4	12.8	0.3	24.5	102.0	7.4	4.0	109.7	4.4	1.6
5	0.8	1.0	6.2	10.9	57.0	1.8	2.1	43.9	6.7
6	4.3	0.3	18.0	4.2	2.3	8.0	2.2	1.9	54.4
7	0.3	2.1	0.1	11.5	1.3	0.5	4.5	1.7	2.1
8	0.8	-	3.6	0.2	2.0	0.1	0.6	1.6	1.7
9	0.2	1.6	-	4.5	-	0.6	0.1	0.5	1.1
10	1.8	0.1	0.8	0.9	1.8	-	0.8	0.2	0.2
11+	101.2	82.0	80.3	96.0	44.5	17.6	10.4	6.3	4.1
Total	144.0	91.5	231.3	239.2	142.6	85.1	138.7	64.4	93.4

Autumn and spring spawners combined

	1980*	1981*	1982*	1983	1984	1985	1986	1987	1988
1	-	-	-	-	-	-	-	-	0.7
2	20.6	1.7	6.4	0.9	18.1	2.1	2.4	3.7	5.4
3	2.0	2.5	117.3	8.4	8.1	50.7	6.0	0.3	15.8
4	14.0	2.1	28.5	135.6	8.6	4.9	110.4	4.7	2.1
5	1.3	1.3	19.6	19.3	80.3	2.3	4.5	44.6	7.6
6	5.4	0.5	18.5	14.1	7.8	16.8	5.0	2.7	55.5
7	2.8	2.3	2.3	13.8	6.2	4.3	12.2	2.2	2.7
8	1.4	3.1	3.7	1.6	2.5	0.9	2.6	4.3	1.8
9	0.5	1.7	6.5	5.2	1.9	0.8	1.4	1.2	2.5
10	1.8	0.1	0.8	5.2	1.8	-	0.9	0.3	0.9
11+	103.2	83.5	87.2	100.5	48.8	18.7	11.4	6.9	5.9
Total	153.1	989.9	290.9	305.7	184.2	102.1	156.8	70.9	100.8

Table 17. Catch rates at age (numbers of herring) by area and season calculated from catch/effort data and biological samples for the research gillnet program.

Autumn spawners

Area	Season	Age	1980	1981	1982	1983	1984	1985	1986	1987	1988
BB-TB	Spring	1	–	–	–	–	–	–	–	–	–
		2	–	–	–	–	–	–	–	–	–
		3	–	–	–	1.2	–	–	–	–	–
		4	–	–	–	6.6	–	–	–	0.3	–
		5	–	–	–	0.6	38.9	0.5	–	–	0.3
		6	–	–	–	0.6	6.3	10.8	0.6	0.3	0.2
		7	–	–	–	–	–	1.9	0.9	0.4	0.2
		8	–	–	–	0.6	–	1.3	0.2	1.3	–
		9	–	–	–	–	0.4	–	–	0.7	0.5
		10	–	–	–	–	–	0.1	–	–	–
		11+	–	–	–	2.8	2.1	0.7	–	–	0.3
		Total	–	–	–	12.4	47.7	15.3	1.7	3.0	1.5

Spring spawners

			1980	1981	1982	1983	1984	1985	1986	1987	1988
		1	–	–	–	–	–	–	–	–	–
		2	–	–	–	–	1.0	–	1.6	0.3	0.1
		3	–	–	–	4.4	20.1	18.3	0.8	1.1	5.8
		4	–	–	–	35.8	8.1	7.6	151.5	1.1	0.3
		5	–	–	–	1.2	37.6	4.3	2.4	104.5	2.3
		6	–	–	–	–	3.6	11.2	2.6	1.5	80.0
		7	–	–	–	0.6	0.6	1.0	3.1	–	0.5
		8	–	–	–	–	2.3	1.0	0.9	–	0.4
		9	–	–	–	10.0	–	1.0	0.3	0.4	0.6
		10	–	–	–	1.6	2.1	1.1	0.2	0.7	–
		11+	–	–	–	18.1	146.4	39.3	10.8	6.4	12.5
		Total	–	–	–	71.7	221.8	84.8	174.2	116.0	52.5

Autumn and spring spawners combined

			1980	1981	1982	1983	1984	1985	1986	1987	1988
		1	–	–	–	–	–	–	–	–	–
		2	–	–	–	–	1.0	–	1.6	0.3	1.1
		3	–	–	–	5.6	20.1	18.3	0.8	1.1	5.8
		4	–	–	–	42.4	8.1	7.7	151.5	1.4	0.3
		5	–	–	–	1.6	76.5	4.8	2.4	104.5	2.6
		6	–	–	–	0.6	9.9	22.0	3.2	1.8	30.2
		7	–	–	–	0.6	0.6	2.9	3.9	0.4	0.7
		8	–	–	–	0.6	2.3	2.3	1.1	1.4	0.5
		9	–	–	–	10.0	0.4	1.0	0.3	1.1	1.0
		10	–	–	–	1.6	2.1	1.2	0.2	0.7	–
		11+	–	–	–	183.8	148.6	40.1	10.8	6.4	12.8
		Total	–	–	–	245.2	269.6	100.3	175.8	119.1	55.0

Table 18. Catch rates at age (numbers of herring) by area and season calculated from catch/effort data and biological samples for the research gillnet program.

Autumn spawners

Area	Season	Age	1980	1981	1982	1983	1984	1985	1986	1987	1988
CB-SS	Fall	1	-	-	-	-	-	-	-	-	-
		2	-	-	-	1.9	-	-	-	-	-
		3	-	-	-	0.2	7.2	4.4	0.1	-	0.1
		4	-	-	-	4.6	6.3	12.8	2.4	-	-
		5	-	-	-	0.8	213.7	7.5	4.0	-	0.3
		6	-	-	-	1.3	39.4	53.6	2.6	-	0.2
		7	-	-	-	0.1	10.4	16.6	9.2	-	0.7
		8	-	-	-	0.1	1.1	11.0	4.1	-	0.6
		9	-	-	-	1.1	1.8	-	2.1	-	5.3
		10	-	-	-	-	1.0	0.1	1.1	-	1.1
		11+	-	-	-	0.7	1.3	6.4	0.5	-	0.4
		Total	-	-	-	10.8	282.1	112.4	26.1	-	8.8

Spring spawners

			1980	1981	1982	1983	1984	1985	1986	1987	1988
		1	-	-	-	-	-	-	1.5	-	-
		2	-	-	-	2.3	80.2	1.2	0.9	-	14.3
		3	-	-	-	1.2	18.7	460.9	0.4	-	118.0
		4	-	-	-	2.1	67.9	25.8	34.8	-	4.1
		5	-	-	-	0.2	130.1	14.8	2.3	-	6.5
		6	-	-	-	0.3	8.6	18.1	2.4	-	295.7
		7	-	-	-	0.3	7.0	0.1	1.6	-	8.9
		8	-	-	-	-	13.3	1.0	0.2	-	10.7
		9	-	-	-	0.3	-	1.3	0.5	-	0.7
		10	-	-	-	0.3	-	-	0.6	-	-
		11+	-	-	-	7.3	88.8	42.0	3.0	-	2.9
		Total	-	-	-	14.3	414.5	565.0	48.3	-	461.8

Autumn and spring spawners combined

			1980	1981	1982	1983	1984	1985	1986	1987	1988
		1	-	-	-	-	-	-	1.5	-	-
		2	-	-	-	4.3	80.2	1.2	0.9	-	14.3
		3	-	-	-	1.5	25.8	465.3	0.5	-	118.1
		4	-	-	-	6.6	74.2	38.5	37.2	-	4.1
		5	-	-	-	1.0	343.7	22.3	6.3	-	6.8
		6	-	-	-	1.5	48.0	71.7	4.9	-	295.8
		7	-	-	-	0.4	17.4	16.7	10.8	-	9.6
		8	-	-	-	0.1	14.4	12.0	4.3	-	11.3
		9	-	-	-	1.4	1.8	1.3	2.6	-	6.1
		10	-	-	-	0.3	1.0	0.1	1.7	-	1.1
		11+	-	-	-	8.0	90.1	48.3	3.6	-	3.3
		Total	-	-	-	25.0	696.5	677.0	74.4	-	470.6

Table 19. Catch rates at age (numbers of herring) by area and season calculated from catch/effort data and biological samples for the research gillnet program.

Autumn spawners

Area	Season	Age	1980	1981	1982	1983	1984	1985	1986	1987	1988
CB-SS	Spring	1	–	–	–	–	–	–	–	–	–
		2	–	–	–	–	–	–	–	–	–
		3	–	–	–	–	–	–	–	1.2	–
		4	–	–	–	–	–	0.9	0.3	1.2	–
		5	–	–	–	–	–	1.3	4.7	1.4	6.5
		6	–	–	–	–	–	26.6	10.3	4.0	12.1
		7	–	–	–	–	–	20.8	67.0	7.0	20.3
		8	–	–	–	–	–	16.7	20.2	9.6	9.9
		9	–	–	–	–	–	3.4	12.6	1.3	20.1
		10	–	–	–	–	–	1.9	0.8	2.5	0.1
		11+	–	–	–	–	–	27.1	29.9	4.4	3.7
		Total	–	–	–	–	–	98.9	145.9	31.5	72.7

Spring spawners

	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	–	–	–	–	–	–	–	–	–
2	–	–	–	–	–	–	–	–	0.3
3	–	–	–	–	–	8.3	–	19.2	6.3
4	–	–	–	–	–	1.6	122.0	2.4	16.3
5	–	–	–	–	–	6.5	3.3	180.1	22.3
6	–	–	–	–	–	18.7	22.8	8.1	725.4
7	–	–	–	–	–	2.5	5.6	13.6	32.7
8	–	–	–	–	–	2.2	4.4	4.4	69.7
9	–	–	–	–	–	0.5	1.3	3.1	9.6
10	–	–	–	–	–	–	1.3	1.2	2.2
11+	–	–	–	–	–	130.7	57.6	85.4	83.9
Total	–	–	–	–	–	171.0	217.0	317.9	978.7

Autumn and spring spawners combined

	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	–	–	–	–	–	–	–	–	–
2	–	–	–	–	–	–	–	–	0.3
3	–	–	–	–	–	8.3	–	20.5	6.3
4	–	–	–	–	–	2.5	122.4	3.6	26.3
5	–	–	–	–	–	7.8	8.0	180.5	28.9
6	–	–	–	–	–	45.3	33.0	12.5	737.5
7	–	–	–	–	–	23.2	72.6	20.6	53.1
8	–	–	–	–	–	18.9	24.6	14.0	79.6
9	–	–	–	–	–	4.0	12.6	4.3	29.7
10	–	–	–	–	–	1.9	2.1	3.7	2.3
11+	–	–	–	–	–	157.8	87.4	89.7	87.6
Total	–	–	–	–	–	269.9	362.8	349.4	1051.4

Table 20. Catch rates at age (numbers of herring) by area and seasoncalculated from catch/effort data and biological samples for the research gillnet program.

Autumn spawners

Area	Season	Age	1982	1983	1984	1985	1986	1987	1988
SMB-PB	Spring	1	-	-	-	-	-	-	-
		2	-	-	-	-	-	-	-
		3	0.6	0.5	6.2	1.0	0.7	2.0	-
		4	0.6	10.7	10.8	36.8	8.0	4.6	1.1
		5	2.0	2.0	53.2	14.2	16.6	8.2	1.2
		6	0.2	5.5	15.9	39.0	10.2	14.9	2.9
		7	-	1.0	22.7	14.5	42.2	8.5	5.2
		8	0.2	0.5	1.5	12.2	10.4	20.6	5.0
		9	0.1	0.8	4.1	1.5	3.6	7.5	8.3
		10	-	0.4	0.8	2.5	1.5	0.7	1.2
		11+	0.5	2.7	13.5	10.9	4.5	4.6	4.4
		Total	4.1	23.2	128.6	132.5	97.8	71.5	29.3

Spring spawners

	1982	1983	1984	1985	1986	1987	1988
1	-	-	-	-	-	-	-
2	0.2	1.8	0.7	-	-	-	0.5
3	0.2	11.3	18.5	59.2	0.4	13.7	2.3
4	0.6	2.0	21.7	5.8	125.6	1.6	4.2
5	0.4	1.0	6.9	9.9	8.5	151.9	2.7
6	1.4	1.1	2.7	6.9	17.5	11.6	100.3
7	0.2	3.5	0.9	2.4	3.5	17.6	6.2
8	1.7	0.4	7.3	2.1	2.6	3.9	14.3
9	0.4	5.2	0.2	8.6	0.1	2.2	2.9
10	0.4	0.6	10.0	2.7	2.4	0.6	0.2
11+	6.6	21.5	46.7	45.4	12.0	7.3	7.2
Total	11.9	48.4	115.6	143.1	172.5	210.4	140.9

Combined

	1982	1983	1984	1985	1986	1987	1988
1	-	-	-	-	-	-	-
2	0.2	1.8	0.7	-	-	-	0.5
3	0.8	11.8	24.7	60.1	1.1	15.7	2.4
4	1.1	12.7	32.5	42.5	133.6	6.1	5.3
5	2.4	2.2	60.1	24.2	25.1	160.1	3.9
6	1.5	6.6	18.6	46.0	27.7	26.5	103.2
7	0.2	4.6	23.6	16.9	45.7	26.0	11.4
8	1.8	0.9	8.6	14.3	13.0	24.5	19.3
9	0.5	6.0	4.3	10.1	3.7	9.7	11.2
10	0.5	1.0	10.8	5.2	3.9	1.3	1.4
11+	7.1	24.2	60.2	56.3	16.5	11.9	11.7
Total	16.0	71.6	244.2	175.7	270.3	281.9	170.1

Table 21. Catch rates at age (numbers of herring) by area and seasoncalculated from catch/effort data and biological samples for the research gillnet program.

Area	Season	Age	1982	1983	1984	1985	1986	1987	1988
			Autumn spawners						
FB	Spring	1	-	-	-	-	-	-	-
		2	-	-	-	-	-	-	-
		3	-	-	-	0.1	-	-	-
		4	0.3	18.0	-	13.9	8.5	0.1	0.2
		5	1.3	6.0	27.5	7.9	5.0	3.3	0.1
		6	0.2	20.6	10.5	74.0	9.3	4.0	3.0
		7	-	2.0	17.3	38.7	28.3	4.5	3.8
		8	-	1.1	3.6	17.5	9.0	25.6	3.0
		9	-	0.5	0.9	13.8	2.0	10.0	12.1
		10	-	-	0.2	3.3	1.0	5.2	1.1
		11+	0.1	0.7	3.1	5.9	1.7	17.3	13.8
		Total	1.9	48.9	63.1	175.1	64.9	69.9	37.2
			Spring spawners						
			1982	1983	1984	1985	1986	1987	1988
		1	-	-	-	-	-	-	-
		2	0.1	-	-	-	-	-	-
		3	0.6	8.3	-	14.5	-	-	-
		4	0.8	6.0	19.5	2.6	224.4	-	-
		5	0.6	3.9	13.2	205.4	8.7	531.8	3.2
		6	0.1	3.1	5.4	69.7	70.1	11.8	419.6
		7	0.2	2.5	1.3	15.8	48.3	48.2	9.7
		8	6.0	2.7	3.6	4.6	9.9	20.5	50.5
		9	0.3	44.0	0.3	8.7	1.0	4.8	11.2
		10	0.8	4.6	3.9	6.4	1.8	1.2	1.8
		11+	0.8	53.7	90.5	135.7	35.9	72.0	19.6
		Total	10.3	128.7	137.9	463.2	400.1	690.2	515.6
			Combined						
			1982	1983	1984	1985	1986	1987	1988
		1	-	-	-	-	-	-	-
		2	0.1	-	-	-	-	-	-
		3	0.6	8.3	-	14.6	-	-	-
		4	1.1	24.1	19.5	16.4	232.9	0.1	0.2
		5	2.0	9.9	40.7	213.3	13.7	535.1	3.3
		6	0.3	23.7	15.9	143.7	79.5	15.8	422.6
		7	0.3	4.6	18.7	54.6	76.6	52.7	13.6
		8	6.0	3.7	7.2	22.1	18.9	46.1	53.5
		9	0.3	44.5	1.2	22.5	3.0	14.7	23.3
		10	0.8	4.6	4.2	9.7	2.8	6.4	3.0
		11+	0.9	54.3	93.6	141.5	37.7	89.3	33.4
		Total	12.3	177.6	200.9	638.4	465.0	760.1	552.8

Table 22. Research gillnet catch rates (number of fish caught/fishing day), by stock area, spawning type and season in which the nets were fished.

Season fished	Spawning group	Stock area	1980	1981	1982	1983	1984	1985	1986	1987	1988
Spring	SS	WB–NDB	–	–	–	–	–	–	–	–	157
		BB–TB	–	–	–	234	222	85	174	116	52
		CB–SS	–	–	–	–	–	191	217	319	982
		SMB–PB	–	–	11	43	116	143	173	209	141
		FB	–	–	10	142	151	462	399	690	517
	AS	WB–NDB	–	–	–	–	–	–	–	–	10
		BB–TB	–	–	–	12	47	15	2	3	2
		CB–SS	–	–	–	–	–	111	146	32	73
		SMB–PB	–	–	5	28	129	133	98	74	29
		FB	–	–	2	35	69	175	65	70	37
Fall	SS	WB–NDB	896	131	267	518	424	372	236	616	178
		BB–TB	142	92	286	258	143	85	139	64	94
		CB–SS	–	–	–	43	415	709	48	–	461
	AS	WB–NDB	11	2	19	26	73	28	25	69	11
		BB–TB	13	8	59	47	42	17	18	7	7
		CB–SS	–	–	–	38	282	141	26	–	9

Table 23. Preliminary analysis of St. Mary's Bay-Placentia Bay research gillnet data using the multiplicative model.

Dependent variable: Catch

Source	DF	Sum of squares	Mean square	F value	PR > F	R-Square	C.V.
Model	21	1860.292	88.585	10.32	0.0001	0.232	175.673
Error	715	6139.835	8.587		Root MSE		Catch mean
Corrected total	736	8000.127			2.930		1.668

Source	DF	Type I SS	F value	PR > F	DF	Type III SS	F value	PR > F
Week	9	291.977	3.78	0.0001	9	324.600	4.20	0.0001
Fisherman	6	522.809	10.15	0.0001	6	539.475	10.47	0.0001
Year	6	1045.505	20.29	0.0001	6	1045.505	20.29	0.0001

Parameter		Estimate	T for HO: Parameter = 0	PR > ITI	Standard error of estimate
Intercept		-0.221	-0.10	0.9217	2.254
Week	8	-2.280	-0.87	0.3838	2.616
	9	-0.602	-0.27	0.7884	2.243
	10	0.968	0.45	0.6549	2.166
	11	1.779	0.83	0.4068	2.144
	12	1.546	0.73	0.4678	2.129
	13	2.232	1.05	0.2927	2.119
	14	2.410	1.14	0.2554	2.118
	15	3.702	1.74	0.0818	2.124
	16	2.588	1.18	0.2396	2.199
	17	0.000	-	-	-
Fisherman	814	0.794	1.01	0.3152	0.789
	815	-0.259	-0.36	0.7189	0.720
	816	1.660	2.28	0.0230	0.728
	817	1.710	2.35	0.0193	0.729
	830	-1.705	-2.08	0.0376	0.818
	898	0.925	0.91	0.3631	1.016
	899	0.000	-	-	-
Year	1982	-3.883	-8.24	0.0001	0.471
	1983	-1.034	-2.29	0.0225	0.452
	1984	-1.623	-3.92	0.0001	0.413
	1985	-0.659	-1.59	0.1117	0.414
	1986	0.184	0.46	0.6435	0.399
	1987	0.874	2.18	0.0296	0.401
	1988	0.000	-	-	-

Table 24. MARINUS purse seine set details for 1988 acoustic survey.

Set no.	Date	Time	Location	Surface temp.	Bottom temp.	Results
1	Oct. 27	0820	Forche Point, White Bay	6.8	-1.2	caught capelin, mostly immature (1986 yc) - sampled 200 fish
2	Nov. 2	1400	Round Harbour, Green Bay	6.8	4.3	set on a school of herring - seine torn badly - caught nothing
3	Nov. 4	0900	Rattling Brook, Green Bay	6.2	-0.4	caught ~9000 kg of 1987 yc herring - sampled 100 fish
4	Nov. 5	0830	Dock Point, Halls Bay	6.3	1.1	set on a school of herring - caught one herring, 185 mm (1988 yc)
5	Nov. 7	0850	Little Northwest Arm, New Bay	9.4	1.1	caught a mixture of sticklebacks (~4500 kg) and immature (1988 yc) herring and mackerel - no samples taken
6	Nov. 8	1315	Matthew Island, Bay of Exploits	8.3	-0.5	caught an approximately equal mixture of sticklebacks and 1988 yc herring - ~1800 kg total - sampled 100 herring
7	Nov. 10	1620	Tizzards Harbour, Friday Bay	7.3	3.2	caught ~7500 kg of 1987 yc herring - sampled 100 fish
8	Nov. 18	1405	Cottell Reach, Bonavista Bay	10.0	2.7	set on a school of herring - fish were wild - caught nothing
9	Nov. 19	1145	Willis Reach, Bonavista Bay	6.8	2.3	set on a school of herring - too much tide - caught nothing
10	Nov. 21	1310	Wolf Island, Sweet Bay	7.7	3.0	set on a school of mackerel - seine tow rope broke - caught nothing
11	Nov. 30	1630	Smith Sound, Trinity Bay	4.2	2.7	set on a school of herring - fish were too deep - caught nothing
12	Dec. 6	1345	Kitchuses, Conception Bay	5.9	3.1	set on a school of herring - caught nothing - obtained a sample of 100 herring (1987 yc) from a commercial vessel which subsequently set on the same school

Table 25. Biological samples used to calculate mean lengths, mean weights and population numbers at age from the 1988 acoustic survey.

Survey block	Survey dates	Sampling location	Sample block	Sample date	Sample type	# fish sampled	Mean lgt. (cm)	Mean wgt. (g)
2	Oct. 26-31	Grey Island	1	Sept. 26	Comm.	50	343	320
		Baie Verte	3	Sept. 29	Comm.	50	333	307
5	Nov. 3-6	Rattling Brook	5	Oct. 14	Comm.	50	329	291
		Rattling Brook	5	Oct. 16	Comm.	50	338	313
		Kings Point	5	Nov. 4	Res.	50	189	52
		Halls Bay	5	Nov. 16	Comm.	50	339	324
6&7	Nov. 6-8	combined samples from blocks 5 & 8				300	286	222
8	Nov. 8-10	Matthew Lane Is.	8	Nov. 8	Res.	50	183	41
		Swan Is.	8	Nov. 9	Comm.	50	336	312
10	Nov. 10	Tizzards Hr.	10	Nov. 10	Res.	50	186	44
		Fogo Is.	11	Oct. 8	Comm.	50	360	378
15&16	Nov. 17-19	Burnside	15	Oct. 17	Comm.	50	328	290
		Indian Bay	14	Oct. 26	Comm.	50	318	274
		Morris Is.	15	Nov. 5	Comm.	50	325	284
17	Nov. 19-21	Charlston	17	Oct. 20	Comm.	50	275	186
		Charlottetown	17	Nov. 20	Comm.	50	264	148
		Charlottetown	17	Dec. 9	Comm.	50	326	280
21&22	Nov. 19-Dec.3	Southport	21	Nov. 21	Comm.	50	300	225
		Southport	21	Dec. 8	Comm.	50	303	234
		Southport	21	Dec. 28	Comm.	50	303	245
24	Dec. 4-8	Holyrood	19	Nov. 4	Res.	50	323	276

Table 26. Number of fish schools edited as non-herring prior to analysis of 1988 acoustic survey data.

Stock area	Stratum	Herring schools analyzed	Schools edited			
			Capelin	Mackerel	Cod	Unidentified
WB-NDB	1	0	20	0	0	0
	2	2	9	1	3	4
	3	0	0	3	0	2
	4	0	0	3	0	0
	5	28	0	0	1	1
	6	6	0	0	3	1
	7	11	0	0	0	1
	8	6	0	0	0	9
	9	0	0	0	3	0
	10	5	1	0	0	0
	11	0	1	0	0	0
BB-TB	12	0	0	0	0	0
	13	0	0	0	2	0
	14	0	0	0	0	0
	15	3	0	0	0	0
	16	6	0	0	0	0
	17	9	0	0	0	2
	18	0	0	0	0	0
	19	0	0	0	0	0
	20	0	0	0	0	0
	21	10	0	0	0	1
	22	1	0	0	0	0
	23	0	0	0	0	0
CB-SS	24	2	0	0	0	1

Table 27. Backscatter and biomass estimates, by transect and stratum, for White Bay–Notre Dame Bay, from the 1988 acoustic survey.

Stock area	Stratum	Target strength (dB/kg)	Transect no.	Transect lgt. (km)	Transect area (m^2)	Area scattering coeff. (/sr)	Total back scattering (m^2/sr)	Biomass density (kg/m^2)	Total biomass (t/transect)	Set no.	Number of fish sampled
WB-NDB	2	-36.29	21	5.52	5110557	0.000E+00	0	0.00000	0		
			22	2.06	1903597	3.388E-05	106	0.14418	450		
			23	3.44	3189811	0.000E+00	0	0.00000	0		
			24	3.82	3532801	0.000E+00	0	0.00000	0		
			25	2.83	2623877	0.000E+00	0	0.00000	0		
			26	2.39	2212288	0.000E+00	0	0.00000	0		
			27	2.69	2486680	0.000E+00	0	0.00000	0	1	-
			28	3.89	3601399	0.000E+00	0	0.00000	0		
			29	3.54	3275558	0.000E+00	0	0.00000	0		
			30	1.85	1714952	0.000E+00	0	0.00000	0		
			31	5.02	4647520	0.000E+00	0	0.00000	0		
			32	2.89	2675325	0.000E+00	0	0.00000	0		
			33	2.89	2675325	0.000E+00	0	0.00000	0		
			34	2.98	2761073	0.000E+00	0	0.00000	0		
			35	2.67	2469531	3.091E-05	96	0.13155	411		
			36	3.98	3687147	0.000E+00	0	0.00000	0		
			37	2.72	2520979	0.000E+00	0	0.00000	0		
			38	7.54	6979855	0.000E+00	0	0.00000	0		
			39	4.72	4373128	0.000E+00	0	0.00000	0		
			40	4.15	3841492	0.000E+00	0	0.00000	0		
			41	6.57	6088080	0.000E+00	0	0.00000	0		
			42	6.26	5796538	0.000E+00	0	0.00000	0		
			43 & 45	3.04	2812521	0.000E+00	0	0.00000	0		
			44 & 46	2.09	1937896	0.000E+00	0	0.00000	0		
			47 & 50	1.80	1663503	0.000E+00	0	0.00000	0		
			48 & 51	1.50	1389111	0.000E+00	0	0.00000	0		
			49 & 52	2.72	2520979	0.000E+00	0	0.00000	0		
			53	1.30	1200466	0.000E+00	0	0.00000	0		
			54	0.89	823177	0.000E+00	0	0.00000	0		
	Totals		29	97.75	90515167						
	Means				3121213	2.234E-06		0.00951			

Table 27. Continued...

Stock area	Stratum	Target strength (dB/kg)	Transect no.	Transect lgt. (km)	Transect area (m^2)	Area scattering coeff. (/sr)	Total back scattering (m^2/sr)	Biomass density (kg/m^2)	Total biomass (t/transect)	Set no.	Number of fish sampled
	5	-36.28	80,112,113	3.02	2795372	2.529E-06	9	0.01076	40		
			80.1	3.35	3104063	3.263E-05	121	0.13886	514		
			81,114,115	4.09	3790044	6.643E-06	25	0.02827	105	3	50
			82,83,108,116	2.35	2177989	0.000E+00	0	0.00000	0		
			84,85,107,117	1.13	1046121	1.030E-05	38	0.04385	162		
			86,87,106,118	1.07	994672	1.715E-06	6	0.00730	27		
			88,89,105,119	1.26	1166167	2.054E-04	760	0.87437	3236		
			90,91,95,101,102,104,120	4.00	3704296	0.000E+00	0	0.00000	0		
			92,94,96,97,98,99,100,103,121,122,123	10.57	9792376	2.057E-04	761	0.87544	3240		
			93,124,125,131,132	12.82	11867468	4.642E-05	172	0.19756	731		
			94.1	2.41	2229438	5.014E-05	186	0.21338	790		
			109,111	1.28	1183317	0.000E+00	0	0.00000	0		
			110	2.26	2092241	5.497E-06	20	0.02340	87	4	-
			110.1	0.98	908925	0.000E+00	0	0.00000	0		
			126,129,134	13.24	12261907	1.576E-05	58	0.06706	248		
			127,128	2.74	2538129	0.000E+00	0	0.00000	0		
			130,133	1.37	1269064	0.000E+00	0	0.00000	0		
	Totals		17	67.95	62921589						
	Means				3701270	3.428E-05		0.14590			
	6	-36.24	135	0.26	240093	0.000E+00	0	0.00000	0		
			136,137,141	1.54	1423410	0.000E+00	0	0.00000	0		
			137.1	2.31	2143690	1.023E-07	0	0.00044	2		
			138,139,140	3.28	3035465	2.134E-05	80	0.09082	339		
			138.1	2.20	2040793	3.453E-06	13	0.01470	55		
			142,147,152,153,162	7.39	6842658	0.000E+00	0	0.00000	0	5	-
			143,144,154,159	6.06	5607893	0.000E+00	0	0.00000	0		
			145,155,157,160	6.41	5933734	0.000E+00	0	0.00000	0		
			146,156,158,161	5.87	5436398	6.387E-05	238	0.27138	1014		
			148,149,150,151	5.09	4716118	0.000E+00	0	0.00000	0		
			153.1	0.98	908925	5.540E-06	21	0.02358	88		
			158.1	1.26	1166167	6.577E-05	245	0.27992	1044		
			163,165	4.74	4390277	0.000E+00	0	0.00000	0		
			164,166	9.02	8351816	0.000E+00	0	0.00000	0		
	Totals		14	56.41	52237438						
	Means				3731246	1.143E-05		0.04866			

Table 27. Continued ...

Stock area	Stratum	Target strength (dB/kg)	Transect no.	Transect lgt. (km)	Transect area (m^2)	Area scattering coeff. (/sr)	Total back scattering (m^2/sr)	Biomass density (kg/m^2)	Total biomass (t/transect)	Set no.	Number of fish sampled
	7	-36.24	167	1.67	1543457	0.000E+00	0	0.00000	0		
			168	0.13	120047	0.000E+00	0	0.00000	0		
			169	0.69	634532	0.000E+00	0	0.00000	0		
			170	1.44	1337663	4.209E-05	43	0.17912	184		
			171	1.09	1011822	0.000E+00	0	0.00000	0		
			180	1.02	943224	0.000E+00	0	0.00000	0		
			181	1.26	1166167	0.000E+00	0	0.00000	0		
			182	1.57	1457709	0.000E+00	0	0.00000	0		
			183	0.54	497336	4.424E-05	45	0.18828	193		
			184	1.67	1543457	9.854E-04	1011	4.19378	4301		
		Totals	10	11.07	10255413						
		Means			1025541	1.072E-04		0.45612			
	8	-36.08	172,173,176 177,211	8.11	7511490	0.000E+00	0	0.00000	0		
			174,175,212	5.11	4733268	0.000E+00	0	0.00000	0		
			177.1	1.19	1097569	0.000E+00	0	0.00000	0		
			178,210	6.80	6293874	3.459E-05	270	0.14772	1149	6	50
			179,209	11.83	10958543	7.656E-06	60	0.03258	254		
			185,188,204	7.02	6499668	2.764E-06	22	0.01176	92		
			186	3.24	3001166	0.000E+00	0	0.00000	0		
			187,203	5.04	4664669	2.791E-06	22	0.01188	93		
			189,191,205	14.17	13119383	0.000E+00	0	0.00000	0		
			190,195,201,202	16.80	15554615	1.800E-06	14	0.00766	60		
			192,193,194,199,200	13.61	12604897	0.000E+00	0	0.00000	0		
			196,197,198	8.20	7597237	0.000E+00	0	0.00000	0		
		Totals	12	101.12	93636379						
		Means			7803032	4.133E-06		0.01759			
	10	-36.42	207	0.35	325841	0.000E+00	0	0.00000	0		
			208	1.07	994672	0.000E+00	0	0.00000	0		
			213,214	9.45	8746255	6.966E-06	26	0.02965	112		
			213.1	1.74	1612055	3.996E-05	151	0.17006	643	7	50
			215	8.43	7803032	4.220E-06	16	0.01796	68		
			216	3.44	3189811	0.000E+00	0	0.00000	0		
		Totals	6	24.48	22671665						
		Means			3778611	8.52E-06		0.03628			

Table 28. Backscatter and biomass estimates, by transect and stratum, for Bonavista Bay-Trinity Bay, from the 1988 acoustic survey.

Stock area	Stratum	Target strength (dB/kg)	Transect no.	Transect lgt. (km)	Transect area (m^2)	Area scattering coeff. (/sr)	Total back scattering (m^2/sr)	Biomass density (kg/m^2)	Total biomass (t/transect)	Set no.	Number of fish sampled
BB-TB	15	-36.23	245,255	3.54	3275558	6.376E-04	1625	2.67879	6830	8	-
			246,254	4.52	4184483	0.000E+00	0	0.00000	0		
			247	1.28	1183317	0.000E+00	0	0.00000	0		
			248	4.00	3704296	0.000E+00	0	0.00000	0		
			249	4.24	3927240	0.000E+00	0	0.00000	0		
			250,251,252	4.39	4064436	0.000E+00	0	0.00000	0		
			253.1	1.61	1492008	9.266E-05	236	0.38934	993		
			254.1	0.93	857476	3.829E-06	10	0.01609	41	9	-
			254.2	0.28	257243	3.003E-05	77	0.12619	322		
		Totals	9	24.78	22946058						
		Means			2549562	8.490E-05		0.35671			
	16	-36.23	253,258	4.30	3978689	0.000E+00	0	0.00000	0		
			257	3.00	2778222	0.000E+00	0	0.00000	0		
			263,264	0.56	514486	0.000E+00	0	0.00000	0		
			265	1.17	1080420	1.054E-04	184	0.44279	773		
			266	2.13	1972195	1.322E-04	231	0.55564	970		
			267	1.52	1406261	0.000E+00	0	0.00000	0		
			268	1.78	1646354	0.000E+00	0	0.00000	0		
			269,270	0.63	583084	0.000E+00	0	0.00000	0		
		Totals	8	15.08	13959709						
					1744964	2.970E-05		0.12480			
	17	-35.83	259,271,308	7.85	7271396	0.000E+00	0	0.00000	0		
			260,272	4.56	4218782	0.000E+00	0	0.00000	0		
			261,273,307	8.02	7425742	0.000E+00	0	0.00000	0		
			262,274,300,301,306	11.39	10546955	3.853E-05	162	0.16187	682		
			275,276,294,295,302,303	8.39	7768733	0.000E+00	0	0.00000	0		
			277,280,293,296,297,304	8.35	7734434	0.000E+00	0	0.00000	0		
			278,279,292,298,305	6.11	5659342	0.000E+00	0	0.00000	0		
			281,284	4.28	3961539	0.000E+00	0	0.00000	0		
			282,283	4.26	3944390	0.000E+00	0	0.00000	0		
			285	1.96	1817849	2.250E-06	9	0.00945	40		
			286	2.59	2400933	0.000E+00	0	0.00000	0		
			287	1.35	1251915	1.735E-06	7	0.00729	31		
			288	2.43	2246587	0.000E+00	0	0.00000	0		
			289	1.98	1834999	2.864E-05	121	0.12033	507		
			290	1.56	1440560	5.997E-06	25	0.02520	106		
			291,299	1.67	1543457	0.000E+00	0	0.00000	0		
			298.1	0.59	548785	4.415E-06	19	0.01855	78	10	-
		Totals	17	77.34	71616396						
		Means			4212729	4.798E-06		0.02016			

Table 28. Continued ...

Stock area	Stratum	Target strength (dB/kg)	Transect no.	Transect lgt. (km)	Transect area (m^2)	Area scattering coeff. (/sr)	Total back scattering (m^2/sr)	Biomass density (kg/m^2)	Total biomass (t/transect)	Set no.	Number of fish sampled
	21	-36.01	313,342	0.74	685981	8.610E-05	235	0.36175	988		
			314,315	1.37	1269064	0.000E+00	0	0.00000	0		
			316,332,356	4.80	4441726	0.000E+00	0	0.00000	0		
			317,331,355	5.48	5076258	2.919E-04	798	1.22651	3251		
			318,330,354	6.85	6345322	0.000E+00	0	0.00000	0		
			319,329,353	5.48	5076258	0.000E+00	0	0.00000	0		
			320,327,351	5.50	5093407	0.000E+00	0	0.00000	0		
			321	1.39	1286214	0.000E+00	0	0.00000	0		
			322	2.20	2040793	0.000E+00	0	0.00000	0		
			323	1.80	1663503	3.904E-06	11	0.01640	45		
			324,328,352	5.65	5230604	3.758E-06	10	0.01579	43		
			325,333,357	6.46	5985182	3.030E-05	83	0.12733	348		
			326,334,358	4.94	4578922	0.000E+00	0	0.00000	0		
			329.1	0.48	445888	3.405E-04	930	1.43056	3909	11	-
			335,336	0.43	394439	0.000E+00	0	0.00000	0		
			337,338	0.59	548785	0.000E+00	0	0.00000	0		
			339,340	0.67	617383	0.000E+00	0	0.00000	0		
			341	0.72	668831	0.000E+00	0	0.00000	0		
			349,350	0.50	463037	0.000E+00	0	0.00000	0		
		Totals	19	56.06	51911597						
		Means			2732189	3.981E-05		0.16728			
	22	-36.01	359	7.39	6842658	3.831E-07	2	0.00161	6		
			360	6.35	5882285	0.000E+00	0	0.00000	0		
			361	1.96	1817849	0.000E+00	0	0.00000	0		
			362,363	5.98	5539295	0.000E+00	0	0.00000	0		
			364	0.22	205794	0.000E+00	0	0.00000	0		
			365	2.76	2555278	0.000E+00	0	0.00000	0		
			366	2.41	2229438	0.000E+00	0	0.00000	0		
			367	1.06	977523	0.000E+00	0	0.00000	0		
			368,373	5.02	4647520	0.000E+00	0	0.00000	0		
			369,370,372	3.11	2881119	0.000E+00	0	0.00000	0		
			371	7.35	6808359	0.000E+00	0	0.00000	0		
			376,379	5.09	4716118	0.000E+00	0	0.00000	0		
			377	4.32	3995838	0.000E+00	0	0.00000	0		
			378	7.82	7237097	0.000E+00	0	0.00000	0		
		Totals	14	60.84	56336173						
		Means			4024012	2.736E-08		0.00011			

Table 29. Backscatter and biomass estimates, by transect and stratum, for Concepiton Bay (only), from the 1988 acoustic survey.

Stock area	Stratum	Target strength (dB/kg)	Transect no.	Transect lgt. (km)	Transect area (m^2)	Area scattering coeff. (/sr)	Total back scattering (m^2/sr)	Biomass density (kg/m^2)	Total biomass (t/transect)	Set no.	Number of fish sampled
CB-SS (CB only)	24	-35.76	388	6.82	6311023	0.000E+00	0	0.00000	0		
			389	5.32	4921912	0.000E+00	0	0.00000	0		
			390,393,416,422,423	13.63	12622047	0.000E+00	0	0.00000	0		
			391,392,417,421,424	11.17	10341161	0.000E+00	0	0.00000	0		
			394,395,397,418,420	11.69	10821347	0.000E+00	0	0.00000	0		
			396,398,399,419	8.98	8317517	0.000E+00	0	0.00000	0		
			397.1	0.26	240093	1.630E+00	84	0.06509	381		
			400,401,404	5.72	5299202	0.000E+00	0	0.00000	0		
			402,403,405	2.11	1955045	0.000E+00	0	0.00000	0	12	50
			402.1	0.61	565934	1.514E-05	78	0.06042	353		
			406	1.30	1200466	0.000E+00	0	0.00000	0		
			407	4.30	3978689	0.000E+00	0	0.00000	0		
			408	3.11	2881119	0.000E+00	0	0.00000	0		
			409	7.91	7322845	0.000E+00	0	0.00000	0		
			410,430	6.39	5916584	0.000E+00	0	0.00000	0		
			411,425	4.19	3875792	0.000E+00	0	0.00000	0		
			412,426	4.39	4064436	0.000E+00	0	0.00000	0		
			413,427	4.59	4253081	0.000E+00	0	0.00000	0		
			414,428	4.43	4098735	0.000E+00	0	0.00000	0		
			415,429	4.78	4424576	0.000E+00	0	0.00000	0		
		Totals	20	111.68	103411606						
		Means			5170580	1.572E-06		0.00628			

Table 30. Backscatter and biomass estimates, by stratum, for White Bay–Notre Dame Bay, from the 1988 acoustic survey.

Stock area	Stratum	Target strength (dB kg^{-1})	Stratum area (m^2)	Stratum area scattering coefficient (sr^{-1})	Total backscattering (m^2 sr^{-1}) Mean	Total backscattering (m^2 sr^{-1}) S.E.	Stratum biomass density (kgm^{-2})	Total stratum biomass Mean	Total stratum biomass S.E.
WB–NDB	1	–	2.286×10^9	0.000	0	–	0.00000	0	–
	2	-36.29	5.420×10^8	2.334×10^{-6}	1211	867	0.00951	5153	3690
	3	–	5.650×10^8	0.000	0	–	0.00000	0	–
	4	–	2.530×10^8	0.000	0	–	0.00000	0	–
	5	-36.28	3.470×10^8	3.428×10^{-5}	11895	5553	0.14590	50627	23635
	6	-36.24	2.730×10^8	1.143×10^{-5}	3121	1858	0.04866	13285	7907
	7	-36.24	4.300×10^7	1.072×10^{-4}	4608	3999	0.45612	19613	17018
	8	-36.08	4.970×10^8	4.133×10^{-6}	2054	1471	0.01759	8743	6261
	9	–	1.360×10^8	0.000	0	–	0.00000	0	–
	10	-36.42	4.200×10^7	8.524×10^{-6}	358	318	0.03628	1524	1353
	11	–	2.745×10^9	0.000	0	–	0.00000	0	–
Combined					23248	7300		98945	31071

Table 31. Backscatter and biomass estimates, by stratum, for Bonavista Bay–Trinity Bay, from the 1988 acoustic survey.

Stock area	Stratum	Target strength (dB kg^{-1})	Stratum area (m^2)	Stratum area scattering coefficient (sr^{-1})	Total backscattering (m^2 sr^{-1}) Mean	S.E.	Stratum biomass density (kgm^{-2})	Total stratum biomass Mean	S.E.
BB-TB	12	–	5.120×10^8	0.000	0	–	0.00000	0	–
	13	–	5.140×10^8	0.000	0	–	0.00000	0	–
	14	–	2.630×10^8	0.000	0	–	0.00000	0	–
	15	-36.23	1.943×10^8	8.490×10^{-5}	16496	13620	0.35671	69313	57232
	16	-36.23	1.714×10^8	2.970×10^{-5}	5093	3670	0.12480	21398	15421
	17	-35.83	3.240×10^8	4.798×10^{-6}	1554	847	0.02016	6531	3559
	18	–	3.580×10^8	0.000	0	–	0.00000	0	–
	19	–	7.960×10^8	0.000	0	–	0.00000	0	–
	20	–	2.250×10^8	0.000	0	–	0.00000	0	–
	21	-36.01	2.250×10^8	3.981×10^{-5}	8958	5493	0.16728	37638	23078
	22	-36.01	3.000×10^8	2.736×10^{-8}	8	8	0.00011	34	33
	23	–	4.410×10^8	0.000	0	–	0.00000	0	–
Combined					32110	15162		134914	63707

Table 32. Backscatter and biomass estimates, by strata, for the Conception Bay portion only of the Conception Bay-Southern Shore stock complex, from the 1988 acoustic survey.

Stock area	Stratum	Target strength (dB kg^{-1})	Stratum area (m^2)	Stratum area scattering coefficient (sr^{-1})	Total backscattering (m^2 sr^{-1}) Mean	Total backscattering (m^2 sr^{-1}) S.E.	Stratum biomass density (kgm^{-2})	Total stratum biomass Mean	Total stratum biomass S.E.
CB-SS (CB only)	24	-36.01	9.320×10^{8}	1.572×10^{-6}	1465	1128	0.00628	5849	4503

Table 33. Comparison of population numbers at age, projected to January 1989, as estimated from the 1987 amd 1988 acoustic surveys, for White Bay-Notre Dame Bay and Bonavista Bay-Trinity Bay.

	WB-NDB		BB-TB	
Year-class	1987 survey	1988 survey	1987 survey	1988 survey
1988	-	0.5	-	0.0
1987	42.6	125.2	0.0	1.2
1986	0.8	9.3	0.0	34.5
1985	15.2	5.4	0.0	111.5
1984	4.7	3.9	5.2	5.9
1983	74.2	40.2	18.9	39.5
1982	194.4	122.4	59.8	240.1
1981	5.0	8.3	0.0	4.4
1980	4.0	16.7	0.0	3.4
1979	12.4	21.9	0.4	0.0
≤1978	10.7	56.6	3.7	17.3

Table 34. Relative year-class strengths of the 1977-87 year-classes as predicted by the environmental recuitment model of Winters and Wheeler (1987). VW = <5% of 1968 year-class; W = 5-20% of 1968 year-class; M = 20-50% of 1968 year-class; S = 50-75%; VS = >75%.

	Relative year-class strength										
Stock	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
WB-NDB	VW	W	W	W	VW	M	W	VW	VW	VW	VW
BB-TB	VW	VW	VW	VW	VW	W	VW	VW	VW	VW	VW
CB-SS	VW	VW	W	VW	VW	W	VW	VW	VW	VW	VW
SMB-PB	VW	VW	VW	VW	VW	W	VW	VW	VW	VW	VW
FB	W	W	W	W	VW	M	W	VW	VW	VW	VW

Table 35. White Bay-Notre Dame Bay fishing mortality matrix for retrospective cohort analysis using 1988 acoustic survey population vector.

Age/Year	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
2	.000	.000	.000	.000	.000	.000	.001	.004	.000	.000
3	.000	.000	.001	.006	.000	.003	.005	.045	.005	.002
4	.000	.002	.005	.003	.001	.016	.015	.028	.071	.005
5	.000	.002	.009	.007	.009	.006	.021	.018	.109	.138
6	.000	.002	.001	.024	.017	.020	.014	.021	.050	.155
7	.009	.010	.004	.010	.048	.028	.051	.016	.002	.088
8	.001	.121	.012	.024	.012	.058	.089	.044	.064	.140
9	.030	.018	.021	.015	.072	.018	.090	.088	.085	.074
10	.016	.120	.020	.033	.040	.050	.095	.095	.109	.155
11+	.040	.262	.056	.040	.037	.043	.092	.165	.148	.306

Age/Year	1980	1981	1982	1983	1984	1985	1986	1987	1988
2	.004	.004	.001	.000	.000	.000	.004	.128	.039
3	.003	.006	.004	.001	.001	.001	.012	.076	.196
4	.057	.004	.017	.001	.003	.025	.012	.133	.073
5	.012	.073	.006	.001	.020	.007	.026	.153	.069
6	.069	.010	.020	.002	.006	.030	.023	.191	.090
7	.011	.067	.007	.009	.019	.010	.032	.044	.176
8	.041	.051	.028	.000	.018	.058	.023	.067	.063
9	.044	.036	.019	.003	.011	.014	.044	.057	.061
10	.063	.061	.025	.005	.020	.030	.032	.191	.061
11+	.139	.093	.033	.005	.004	.005	.009	.036	.051

Table 36. White Bay-Notre Dame Bay population numbers and 2+ biomass (t) estimates for retrospective cohort analysis using 1988 acoustic survey population vector.

Age/Year	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
2	785149	677742	155429	22856	54570	6397	51364	15794	37239	18555
3	65418	642817	554887	127250	18712	44678	5236	42003	12886	30487
4	141784	53559	526177	454041	103526	15316	36463	4265	32877	10500
5	55105	116072	43771	428630	370461	84648	12345	29396	3395	25077
6	55798	45094	94886	35517	348376	300465	68894	9893	23644	2493
7	121366	45662	36862	77624	28390	280298	241079	55621	7933	18422
8	17362	98487	37000	30070	62902	22164	223093	187522	44821	6480
9	3113	14204	71419	29928	24027	50869	17131	167139	146868	34426
10	11049	2473	11419	57240	24127	18309	40890	12824	125373	110467
11+	7808	14912	16557	22207	62683	89488	93754	101760	79587	92968
B_2+	170818	238048	274402	282632	262885	233529	202414	164126	132481	90206

Age/Year	1980	1981	1982	1983	1984	1985	1986	1987	1988
2	33031	126133	73435	23851	391074	103009	7612	9209	11502
3	15191	26939	102866	60055	19527	320179	84334	6208	6636
4	24907	12396	21919	83884	49134	15976	261971	68190	4710
5	8552	19270	10112	17645	68637	40116	12764	211912	48854
6	17882	6918	14663	8225	14426	55093	32627	10177	148930
7	1749	13663	5607	11763	6722	11745	43762	26114	6884
8	13807	1416	10458	4560	9546	5400	9518	34711	20450
9	4611	10855	1102	8329	3732	7674	4172	7614	26587
10	26175	3613	8576	885	6796	3022	6198	3270	5890
11+	101562	100819	97914	92811	92851	66893	46155	33692	26603
B_2+	65297	67414	72854	91562	105359	105639	112721	103425	82585

Table 37. Bonavista Bay-Trinity Bay fishing mortality matrix for retrospective cohort analysis using 1988 acoustic survey population vector.

Age/Year	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
2	.000	.000	.000	.000	.000	.001	.004	.023	.014	.021
3	.000	.001	.000	.000	.000	.036	.079	.082	.047	.260
4	.000	.021	.003	.001	.000	.056	.059	.195	.162	.474
5	.000	.006	.033	.015	.003	.011	.066	.121	.271	.615
6	.012	.003	.007	.013	.019	.047	.013	.168	.053	.061
7	.028	.099	.005	.009	.057	.071	.119	.005	.117	.123
8	.121	.060	.032	.000	.017	.080	.140	.219	.076	.147
9	.447	1.130	.027	.022	.028	.138	.227	.230	.239	.090
10	.375	1.126	.269	.019	.039	.088	.176	.306	.200	.530
11+	.263	1.097	1.277	.040	.079	.063	.132	.188	.147	.480

Age/Year	1980	1981	1982	1983	1984	1985	1986	1987	1988
2	.001	.059	.000	.000	.000	.000	.018	.009	.079
3	.059	.025	.004	.000	.002	.000	.006	.070	.067
4	.285	.360	.001	.023	.004	.007	.010	.056	.029
5	.212	.751	.020	.001	.192	.011	.032	.055	.072
6	.507	.191	.175	.025	.002	.566	.026	.063	.079
7	.236	1.572	.051	.124	.081	.009	1.183	.091	.187
8	.102	.155	.836	.013	.138	.818	.011	2.812	.240
9	.155	.174	.046	.454	.032	.218	.850	.015	.240
10	.233	.273	.048	.023	.192	.566	1.183	2.812	.012
11+	.485	1.135	.216	.010	.002	.008	.009	.015	.048

Table 38. Bonavista Bay-Trinity Bay population numbers and 2+ biomass (t) estimates for retrospective cohort analysis using 1988 acoustic survey population vector.

Age/Year	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
2	650240	137571	30789	4076	14779	1364	4292	782	1708	313
3	20131	532371	112632	25207	3337	12099	1115	3501	626	1379
4	23051	16481	435244	92207	20637	2731	9551	844	2642	489
5	26791	18871	13212	355129	75438	16894	2115	7374	569	1840
6	5217	21926	15358	10465	286333	61551	13684	1620	5351	355
7	32476	4221	17894	12492	8454	230091	48074	11053	1121	4154
8	340	25858	3129	14582	10141	6538	175416	34928	9005	816
9	386	247	19929	2483	11938	8166	4941	124891	22979	6831
10	242	202	65	15882	1989	9508	5822	3223	81255	14821
11+	1030	871	329	116	25781	30458	38339	37827	29257	53080
B_2+	96471	123646	139242	136970	125494	116987	99275	78404	56895	35240

Age/Year	1980	1981	1982	1983	1984	1985	1986	1987	1988
2	13217	2638	15831	16571	716565	93419	11708	171204	42298
3	251	10808	2037	12960	13566	586670	76473	9414	13882
4	870	194	8626	1660	10607	11087	480167	62252	7186
5	249	536	110	7053	1329	8653	9014	389361	48177
6	814	165	207	89	5768	898	7006	7151	301832
7	274	402	112	142	71	4714	417	5589	5496
8	3006	177	68	87	103	53	3826	105	4177
9	577	2222	124	24	70	73	19	3097	5
10	5113	405	1529	97	13	56	48	7	2497
11+	31933	17956	5582	5638	12752	10622	8567	7511	5447
B_2+	24458	18242	13101	15880	50069	85919	109654	120171	117141

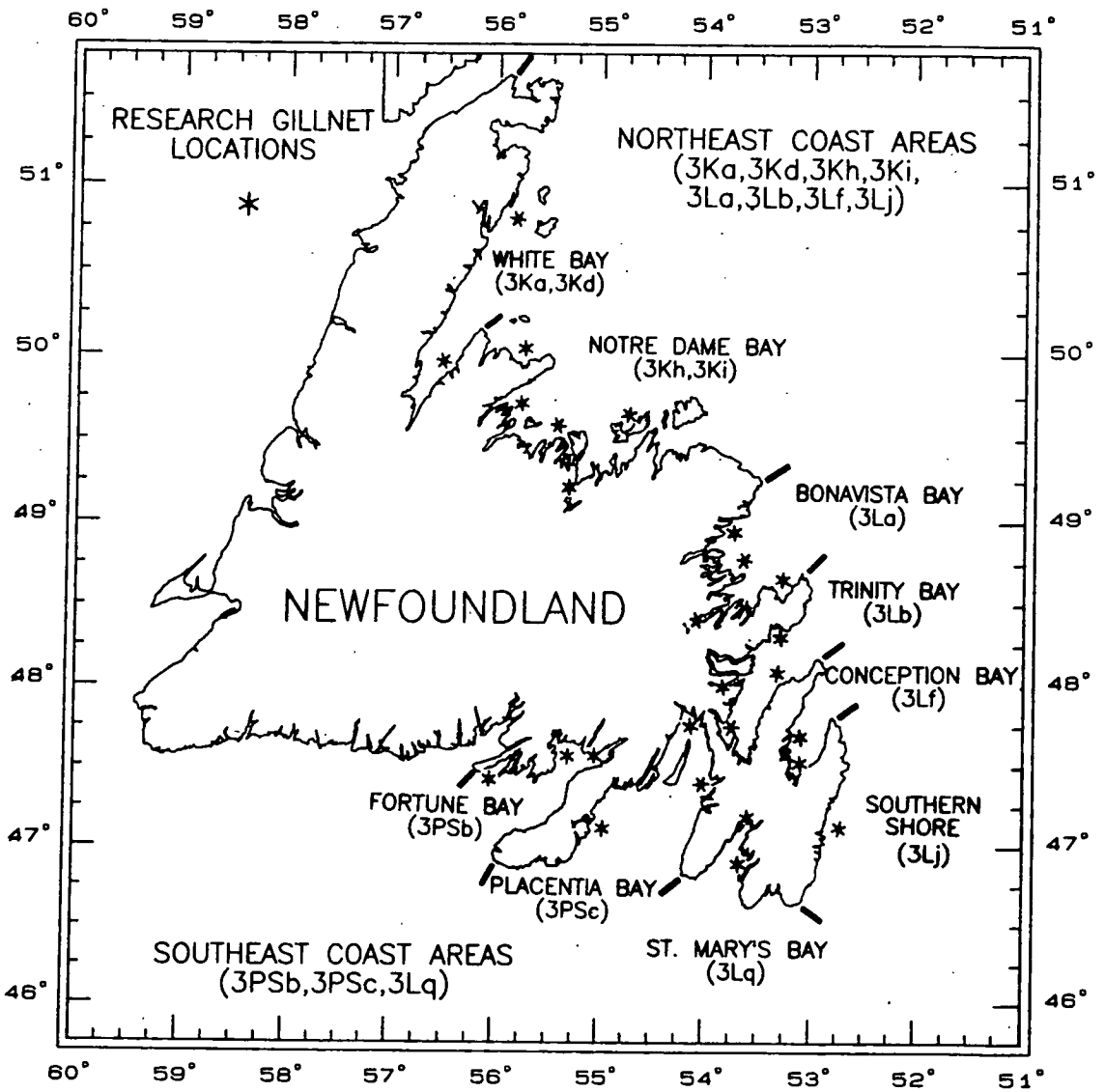


Fig. 1. Area map indicating herring stock complexes and research gillnet locations within the Newfoundland region.

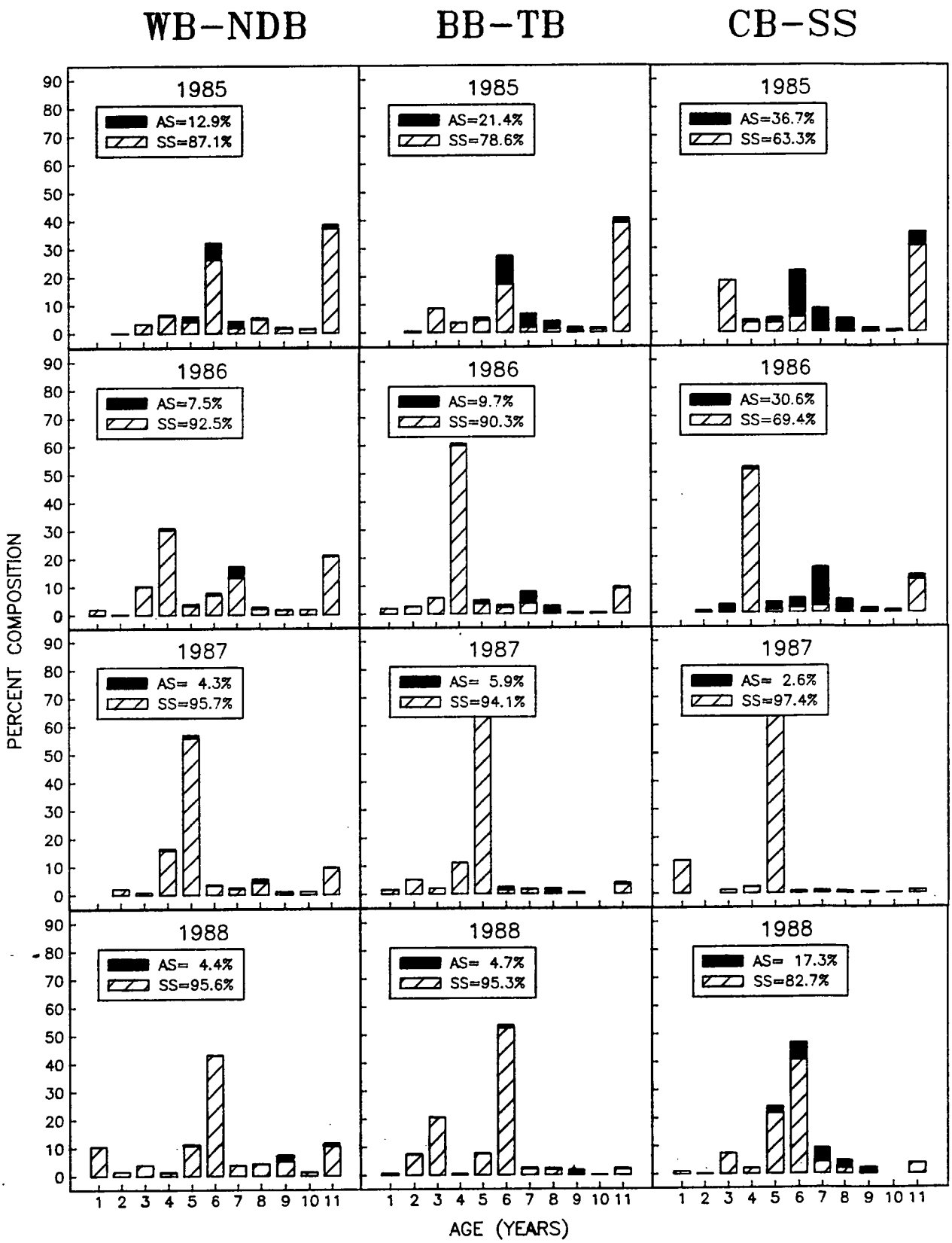


Fig.2. Age composition of herring from the commercial fishery, White Bay – Notre Dame Bay (WB–NDB), Bonavista Bay – Trinity Bay (BB–TB), and Conception Bay – Southern Shore (CB–SS), 1985–88.

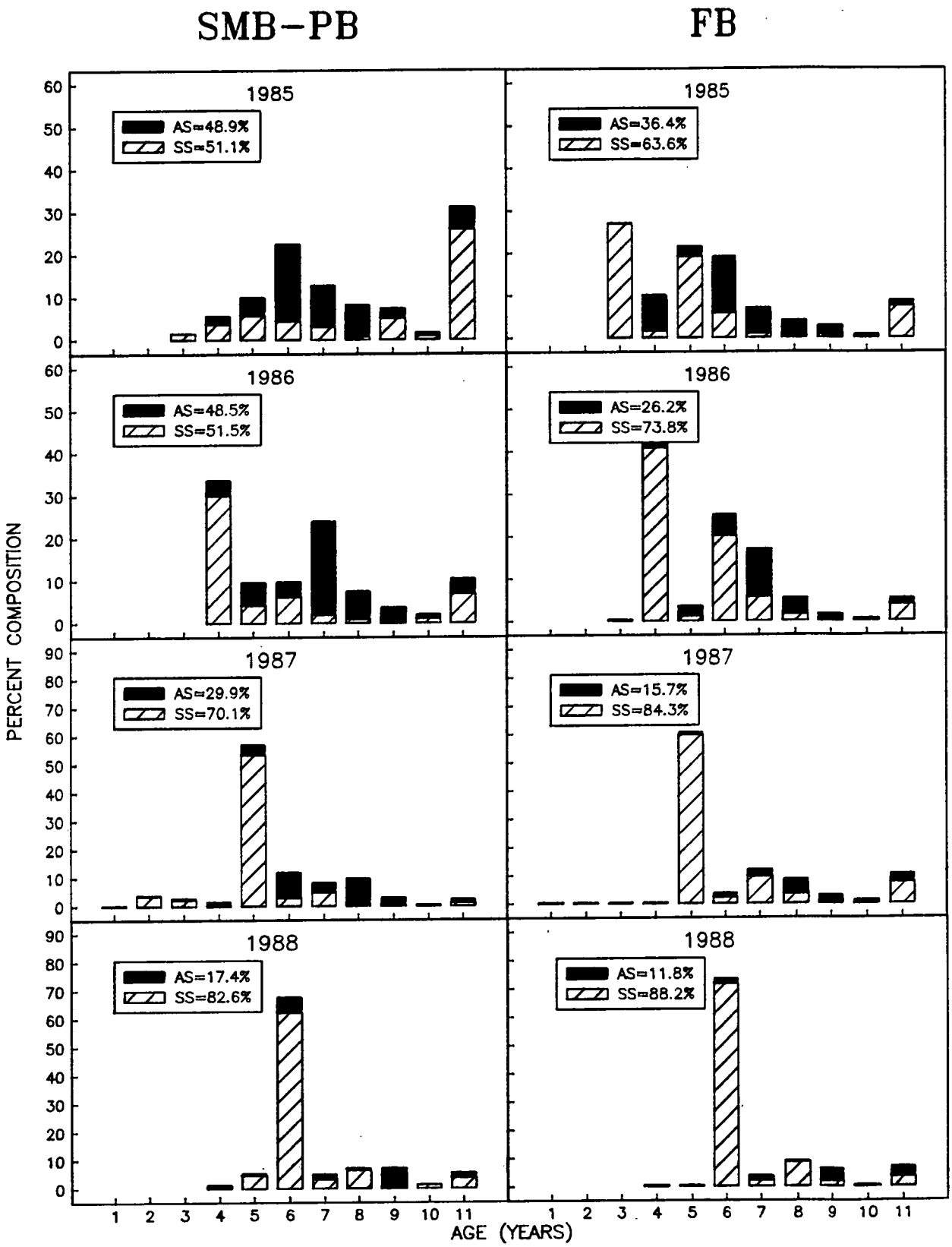


Fig.3. Age composition of herring from commercial fishery, St. Mary's Bay – Placentia Bay (SMB–PB), and Fortune Bay (FB), 1985–88.

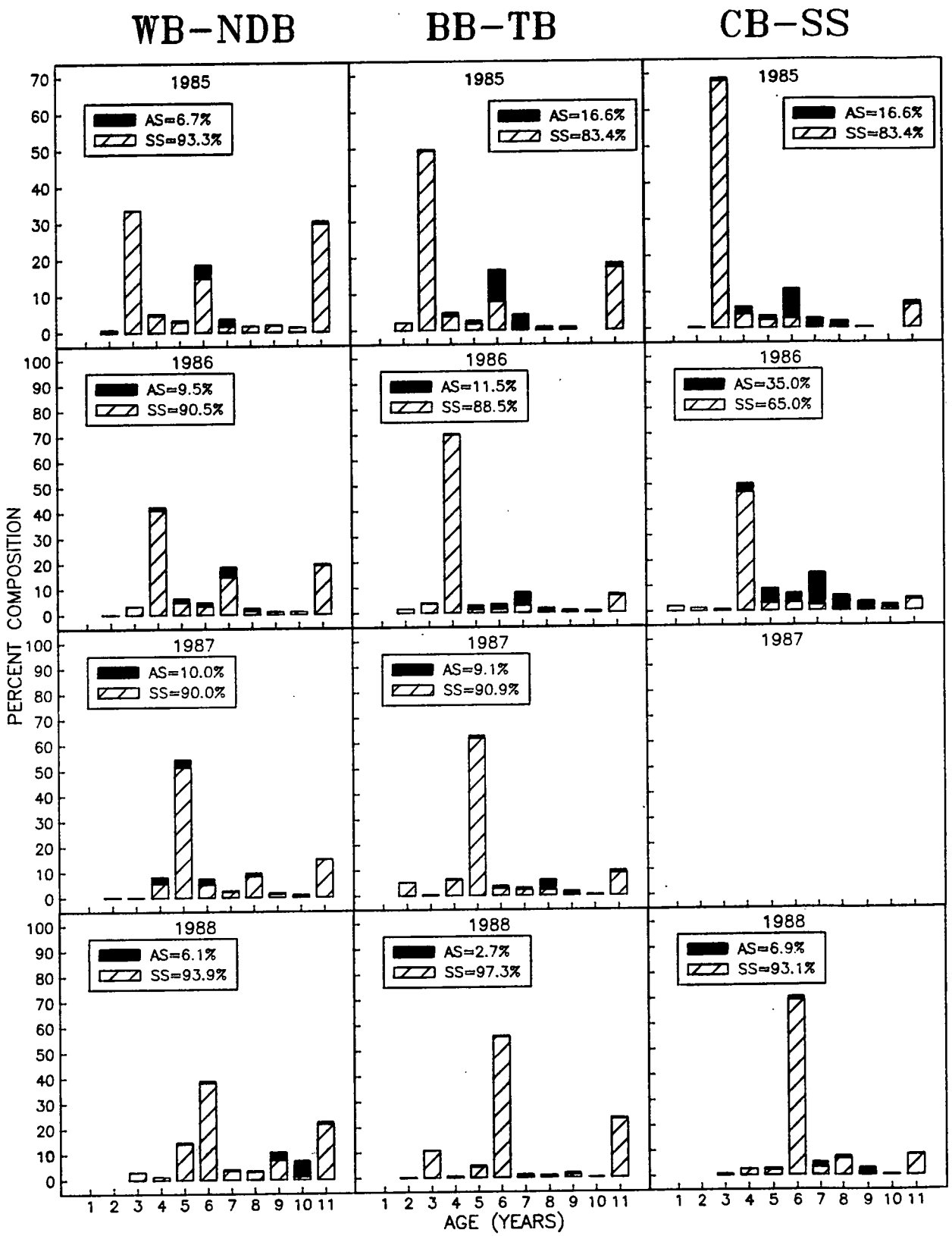


Fig.4. Age composition of herring from research gillnets, White Bay – Notre Dame Bay, Bonavista Bay – Trinity Bay, and Conception Bay – Southern Shore, 1985–88 (fall program from 1985–87 and spring program in 1988).

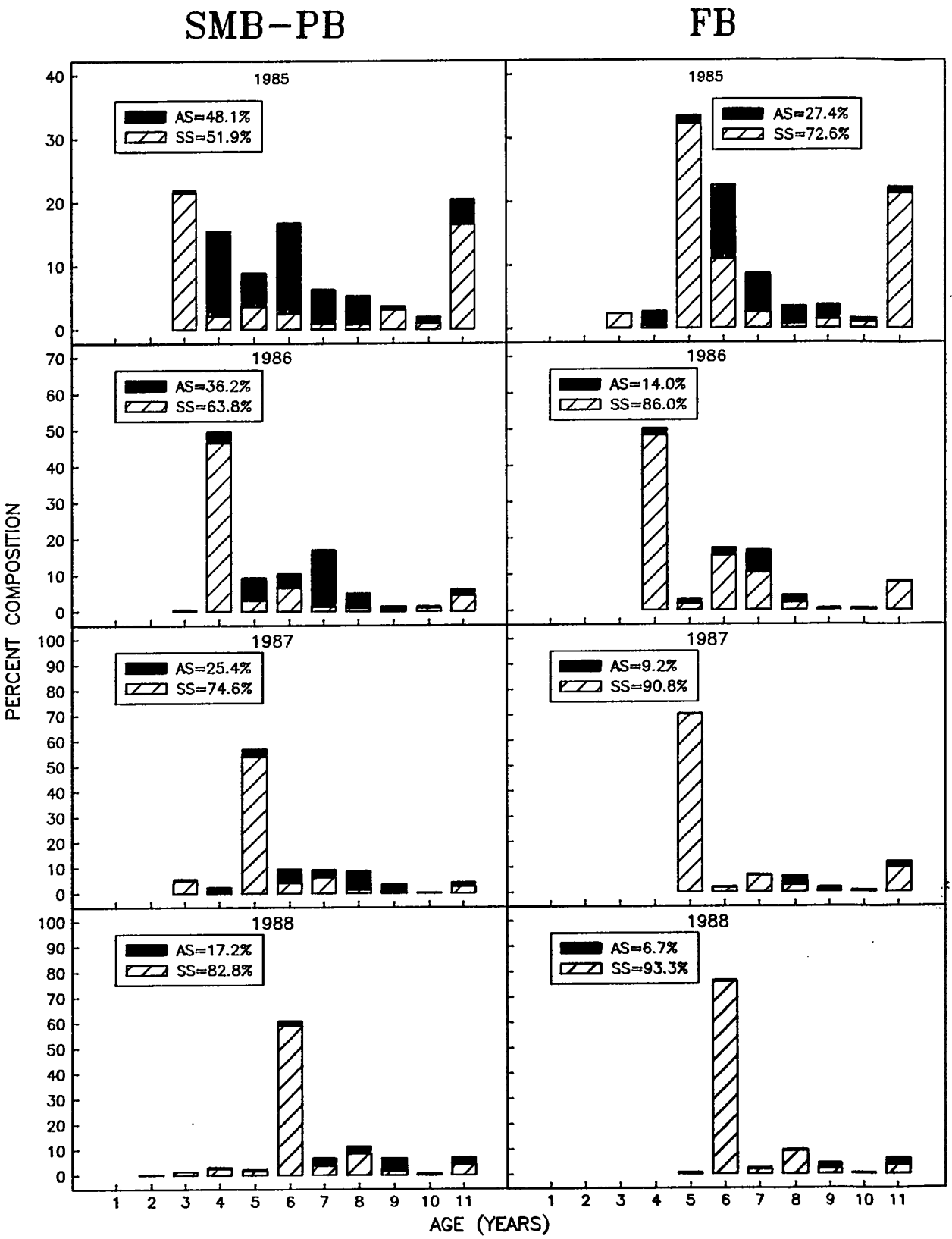


Fig.5. Age composition of herring from research gillnets, (spring program) St. Mary's Bay – Placentia Bay and Fortune Bay, 1985–88.

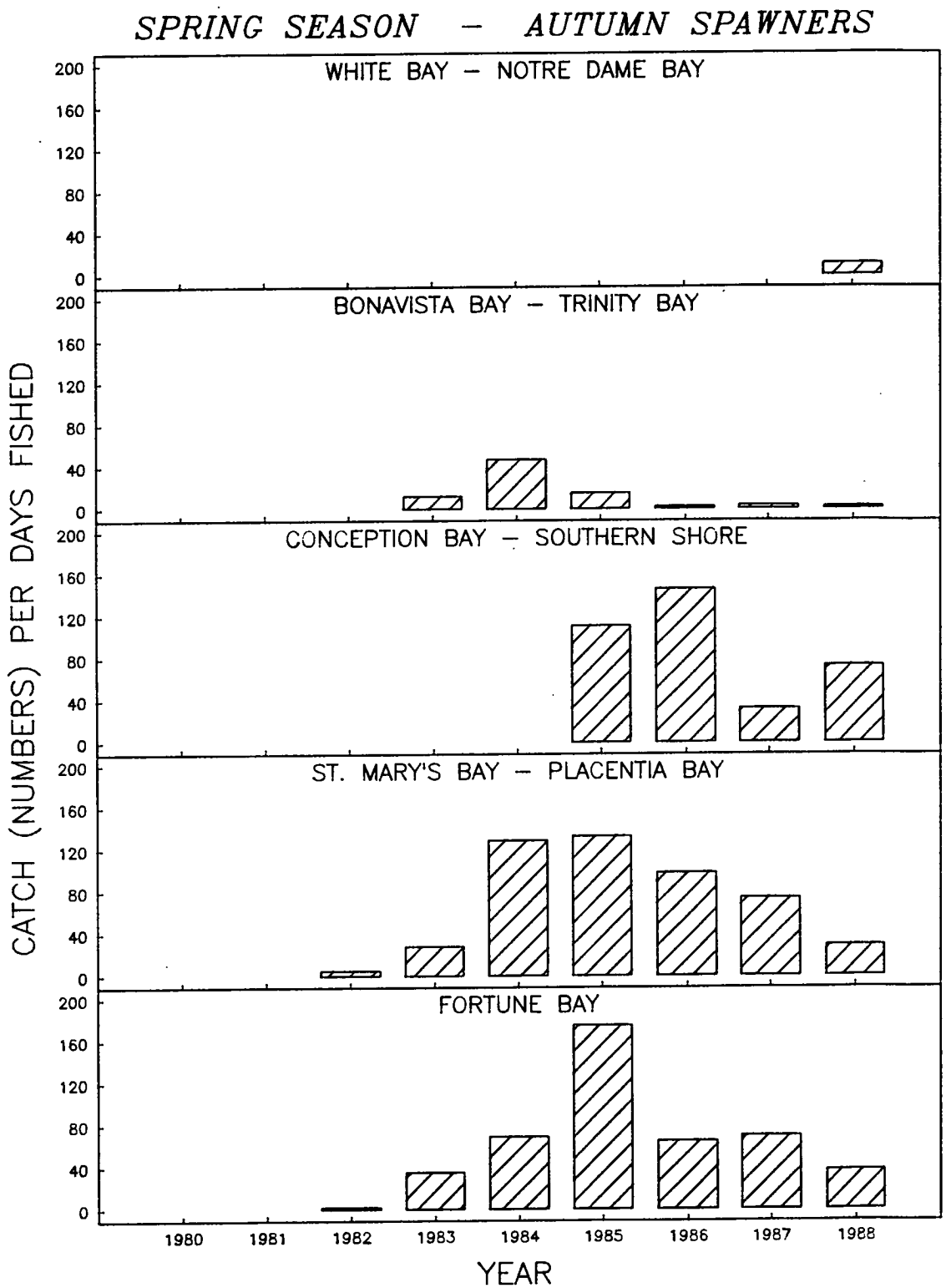


Fig. 6. Catch rate (numbers of fish caught per days fished) from the research gillnet program by year and stock area, for the spring fishing season, autumn spawners only.

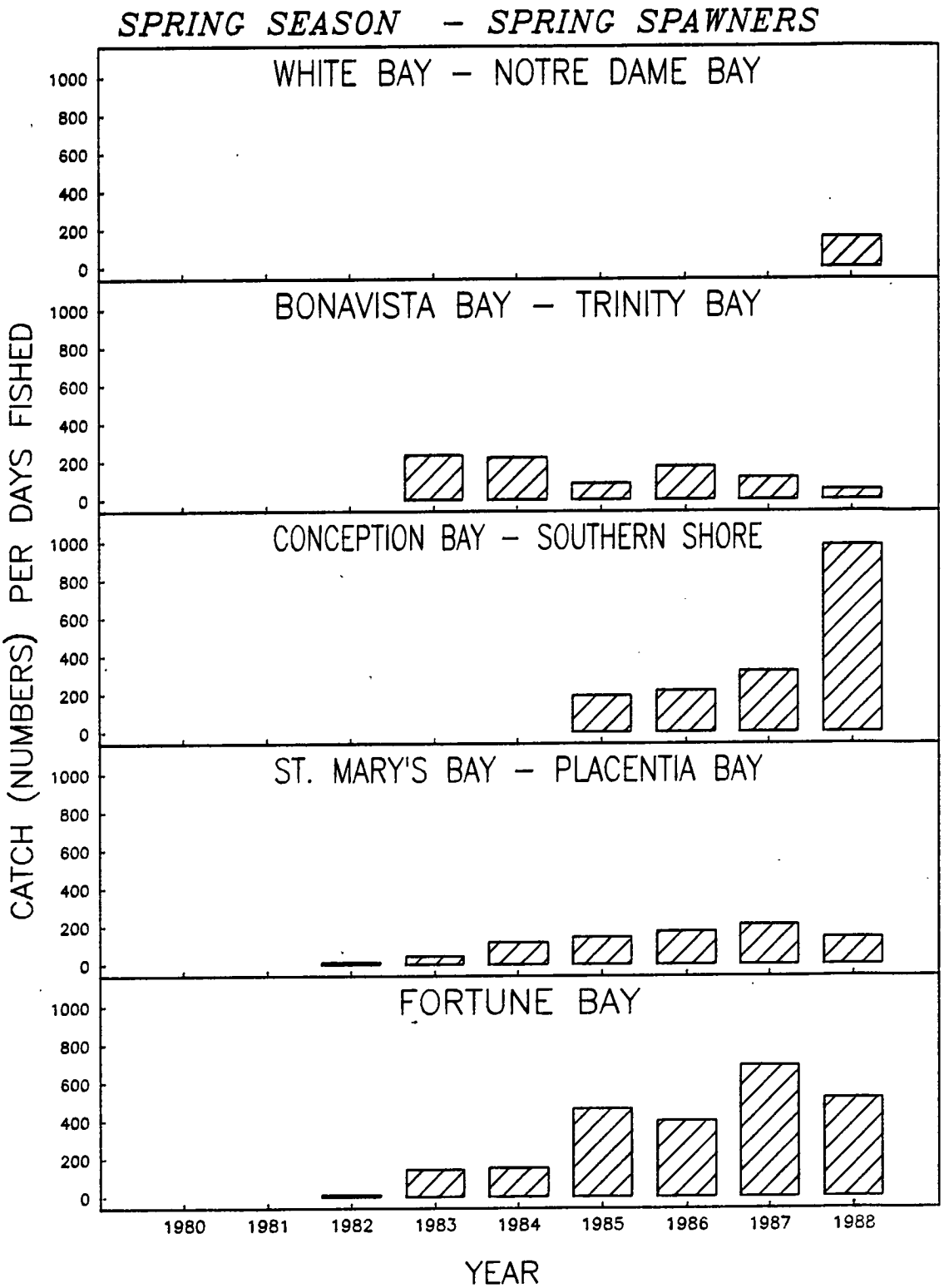


Fig. 7. Catch rate (numbers of fish caught per days fished) from the research gillnet program by year and stock area, for the spring fishing season, spring spawners only.

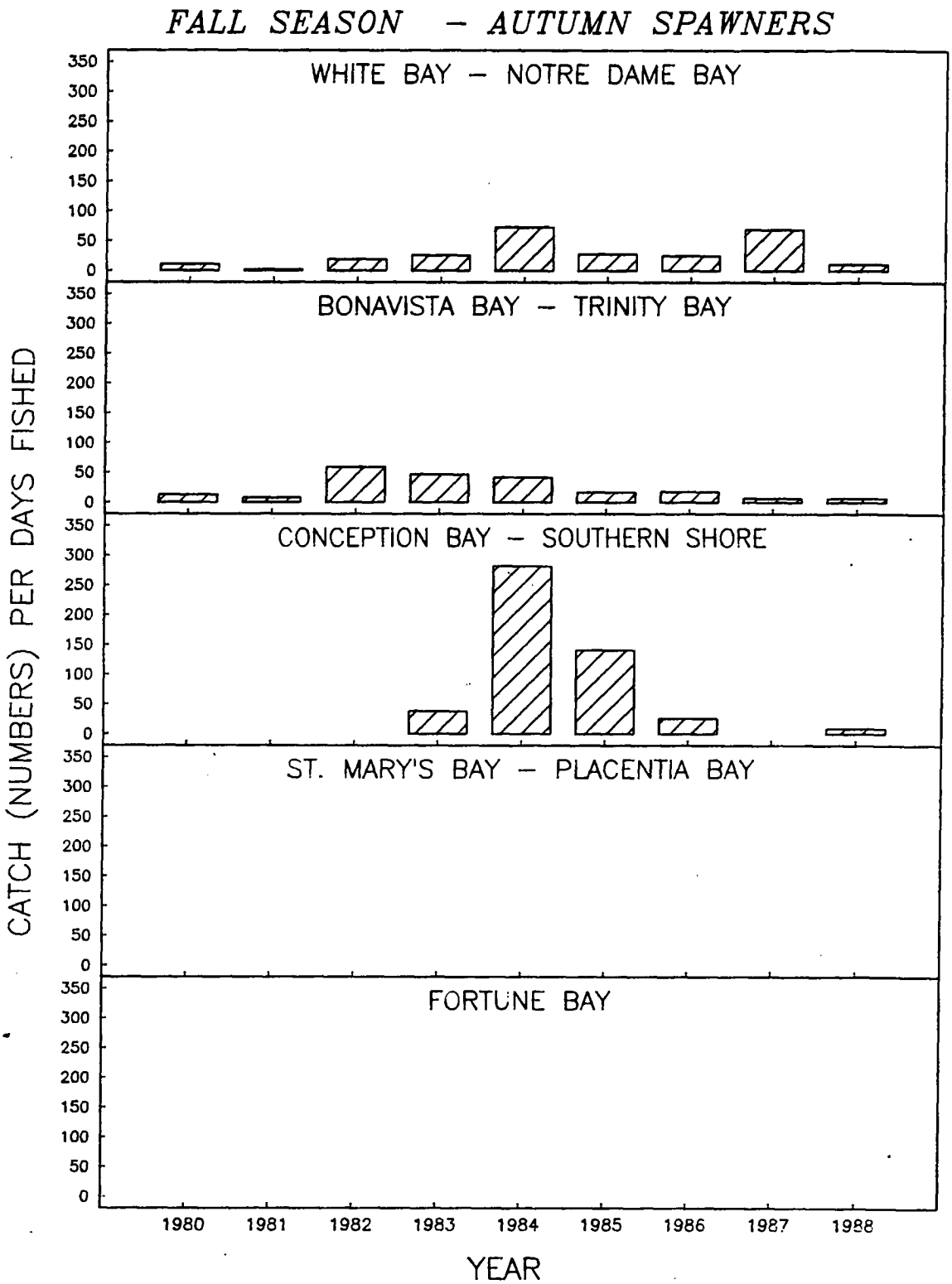


Fig. 8. Catch rate (numbers of fish caught per days fished) from the research gillnet program by year and stock area, for the fall fishing season, autumn spawners only.

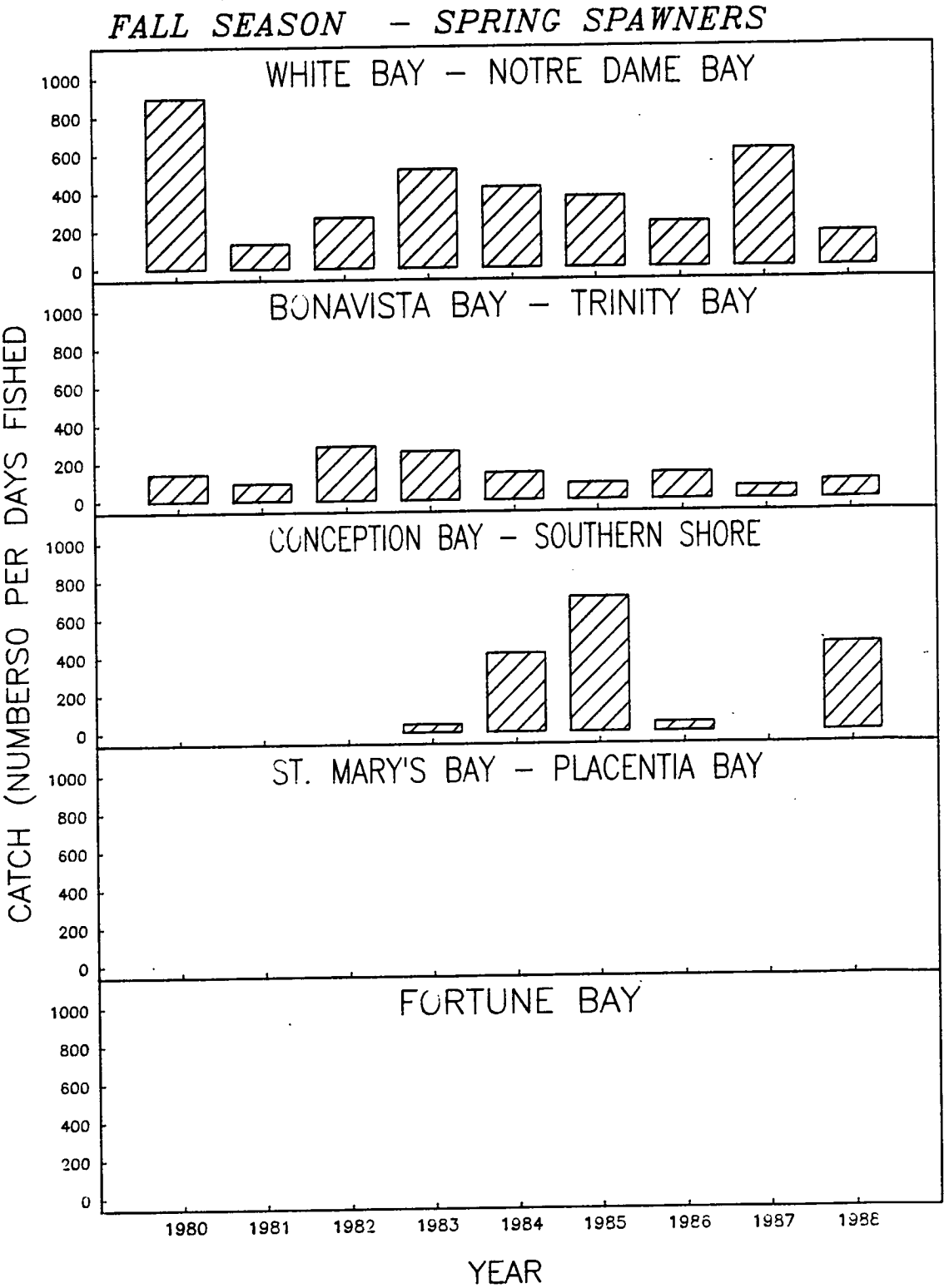


Fig. 9. Catch rate (numbers of fish caught per days fished) from the research gillnet program by year and stock area, for the fall fishing season, spring spawners only.

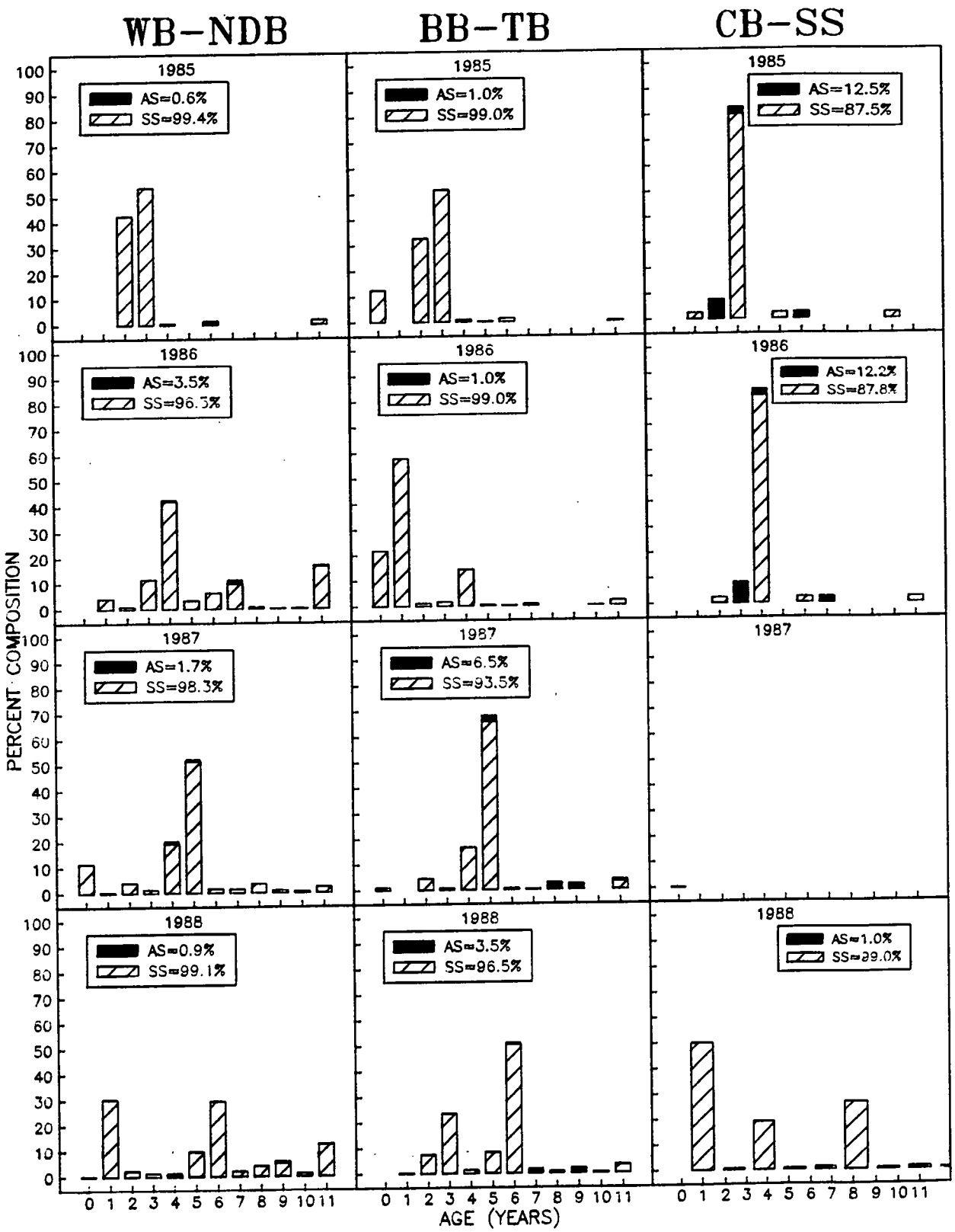


Fig. 10. Stock age composition of herring from acoustic purse seine surveys, 1985–88, for White Bay–Notre Dame Bay (WB–NDB), Bonavista Bay–Trinity Bay (BB–TB), and Conception Bay–Southern Shore (CB–SS).

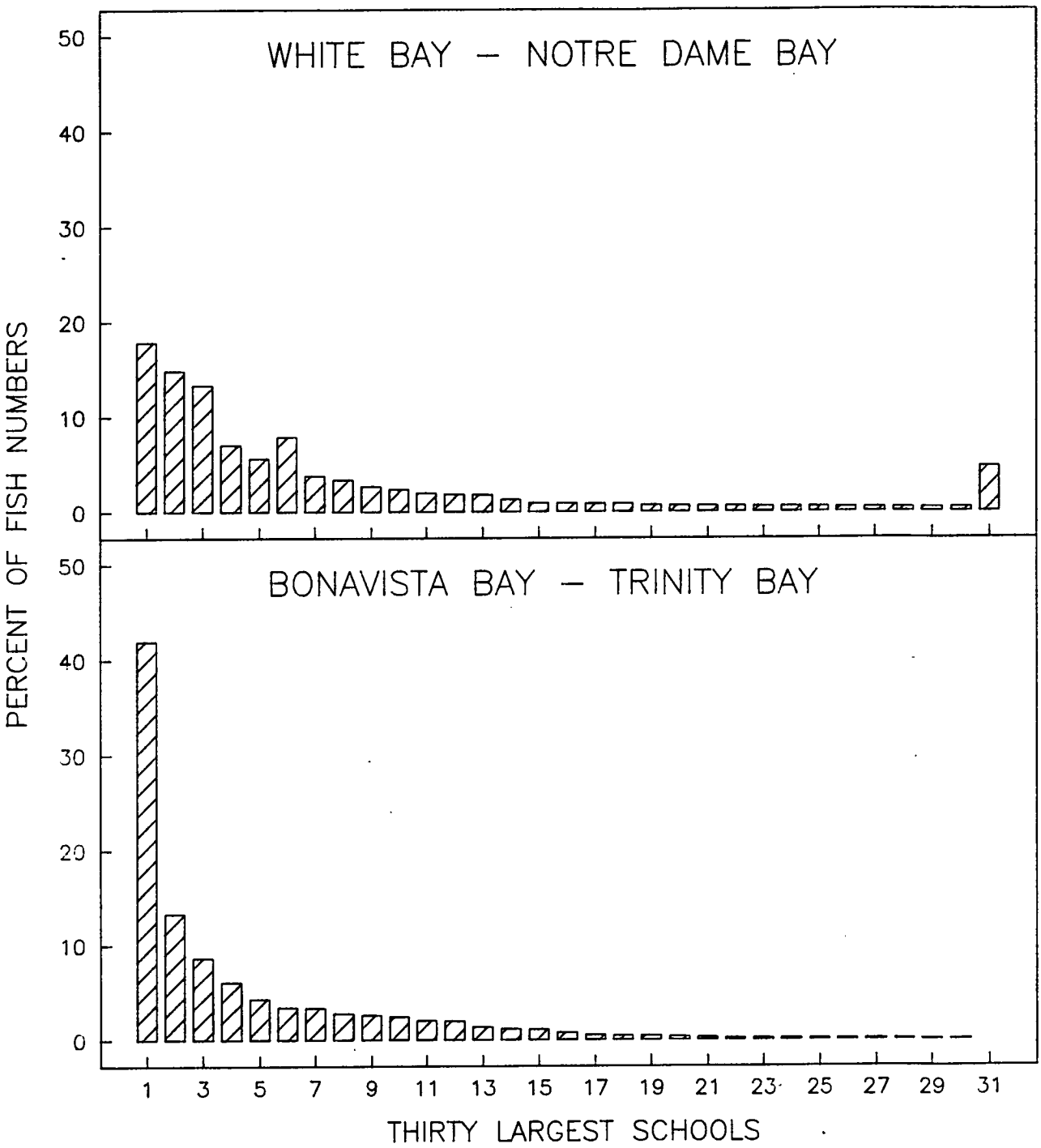


Fig. 11. Contribution of individual schools to the estimate of population numbers from the 1988 acoustic survey. For White Bay – Notre Dame Bay, the remaining 29 schools are summed under position 31.

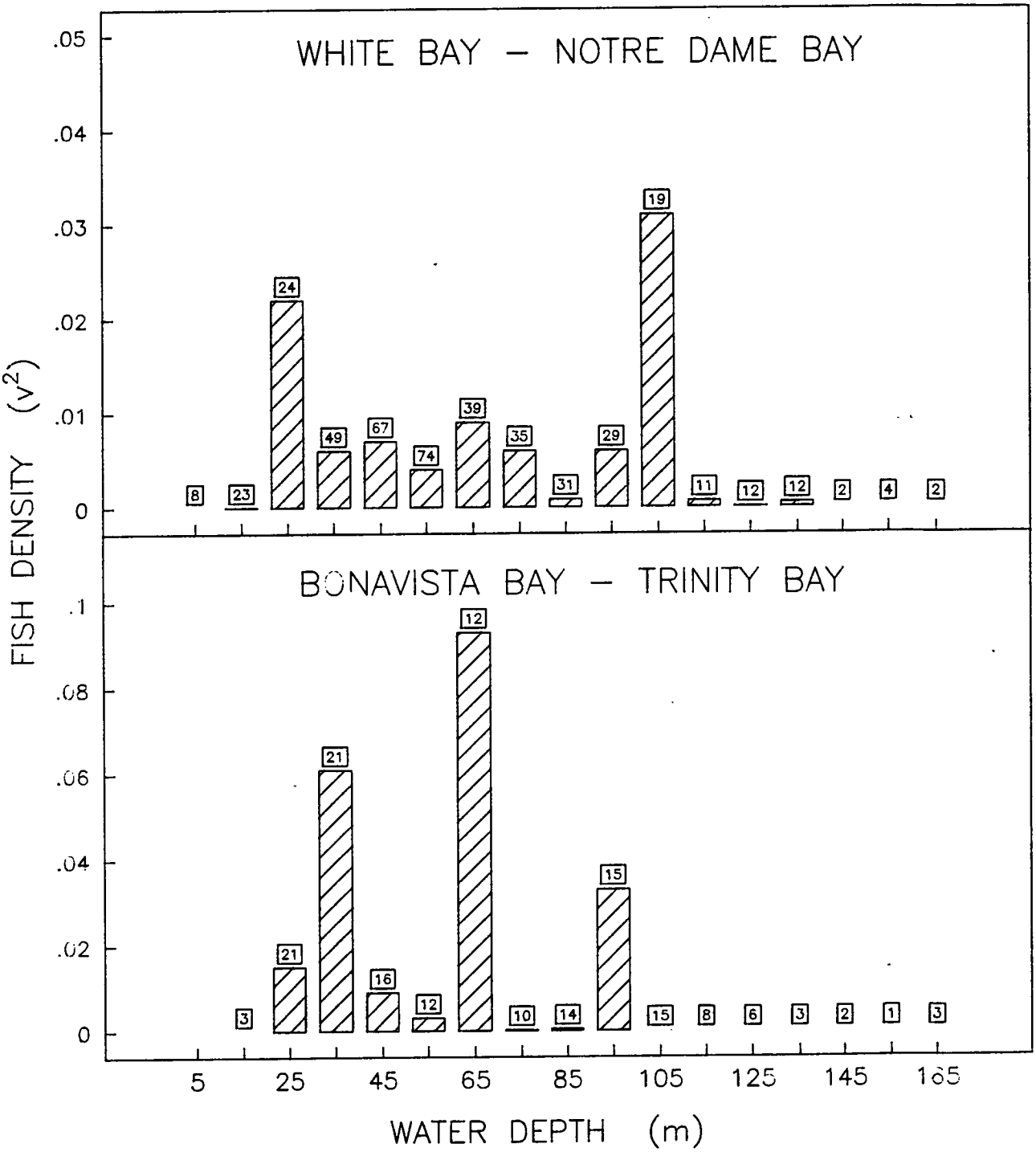
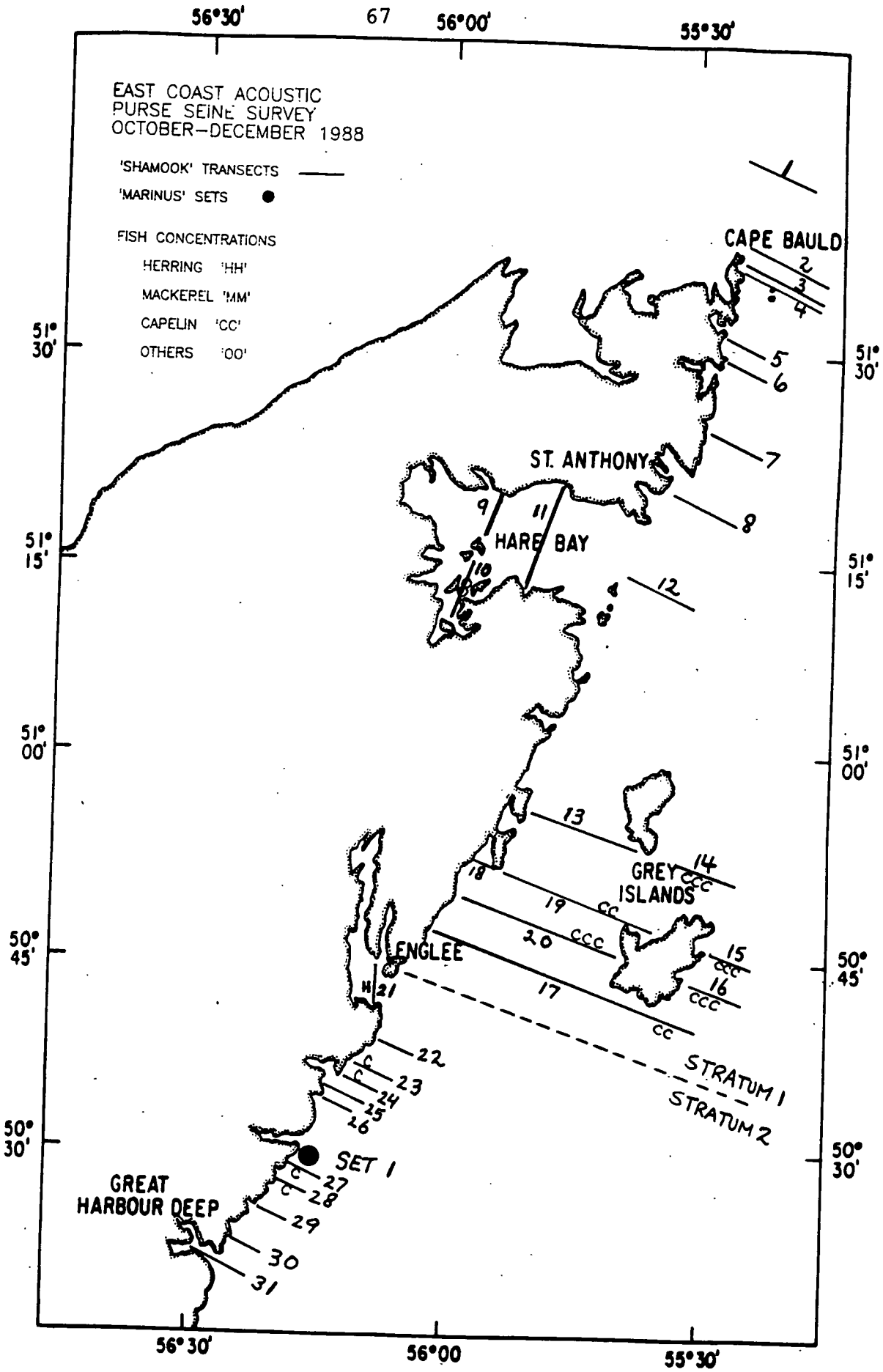
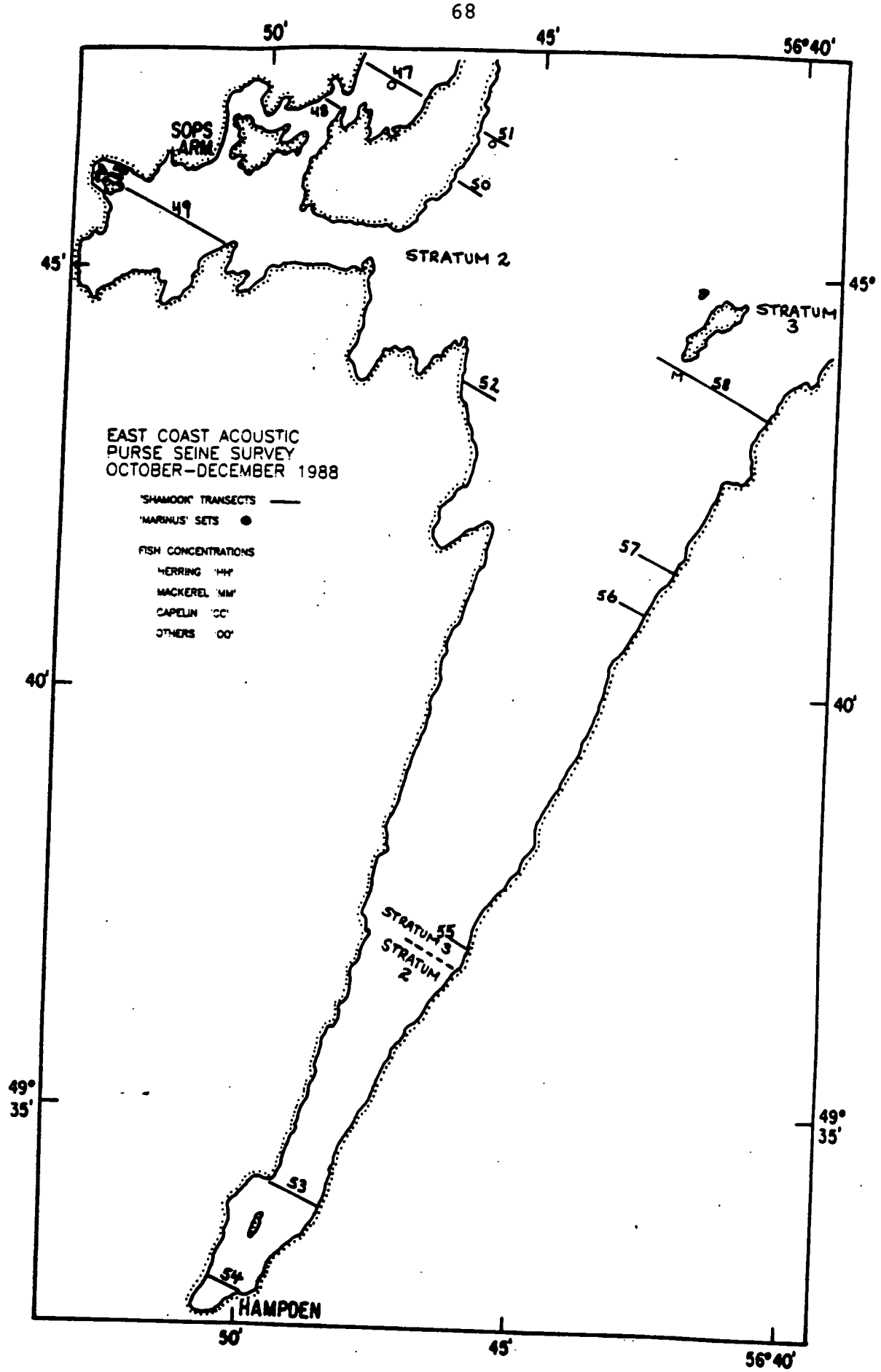


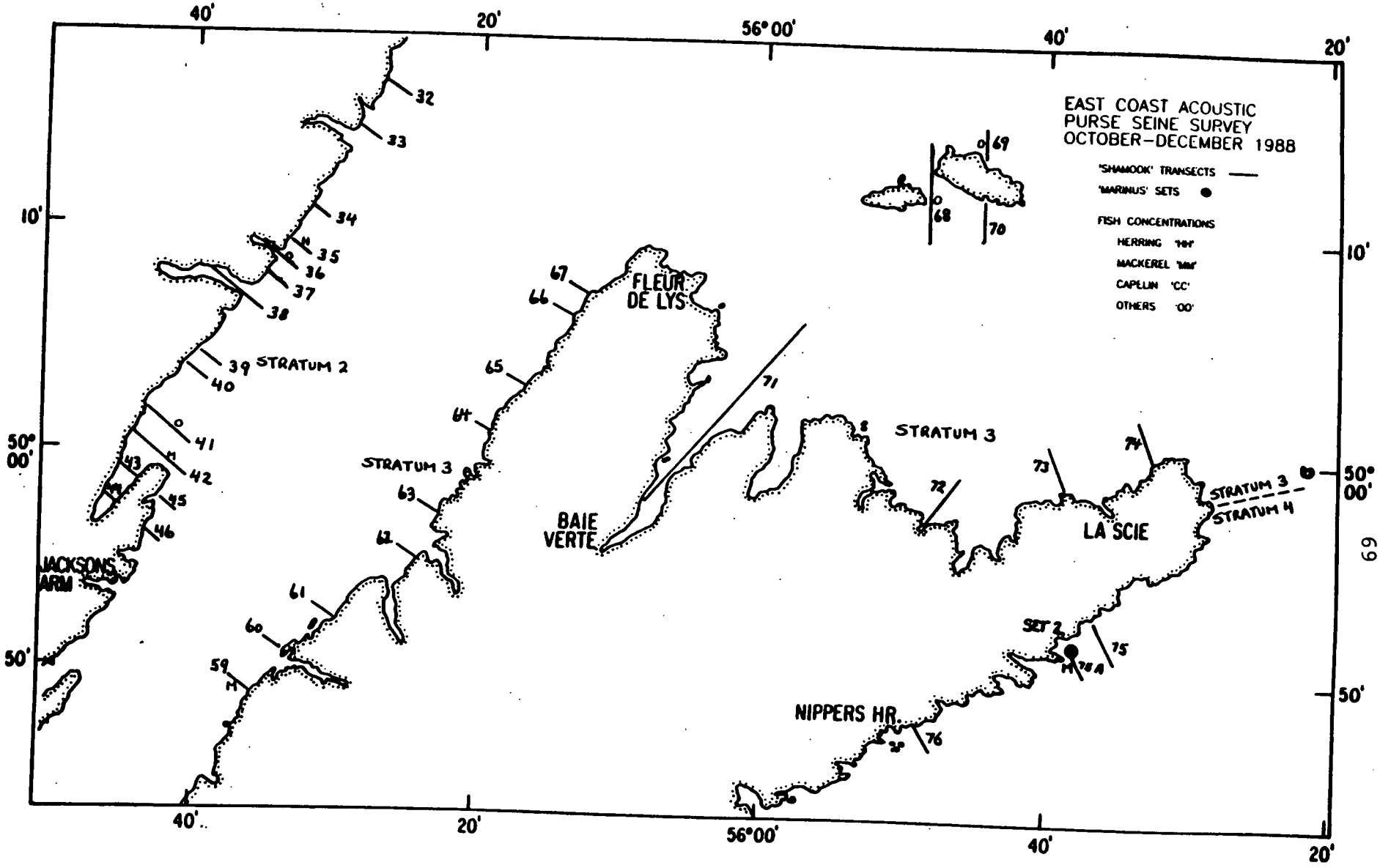
Fig. 12. Mean total density (v^2) per 185 m of transect vs. water depth for those transects on which herring were detected. The numbers above the bars are the number of 185 m segments run in each depth category.



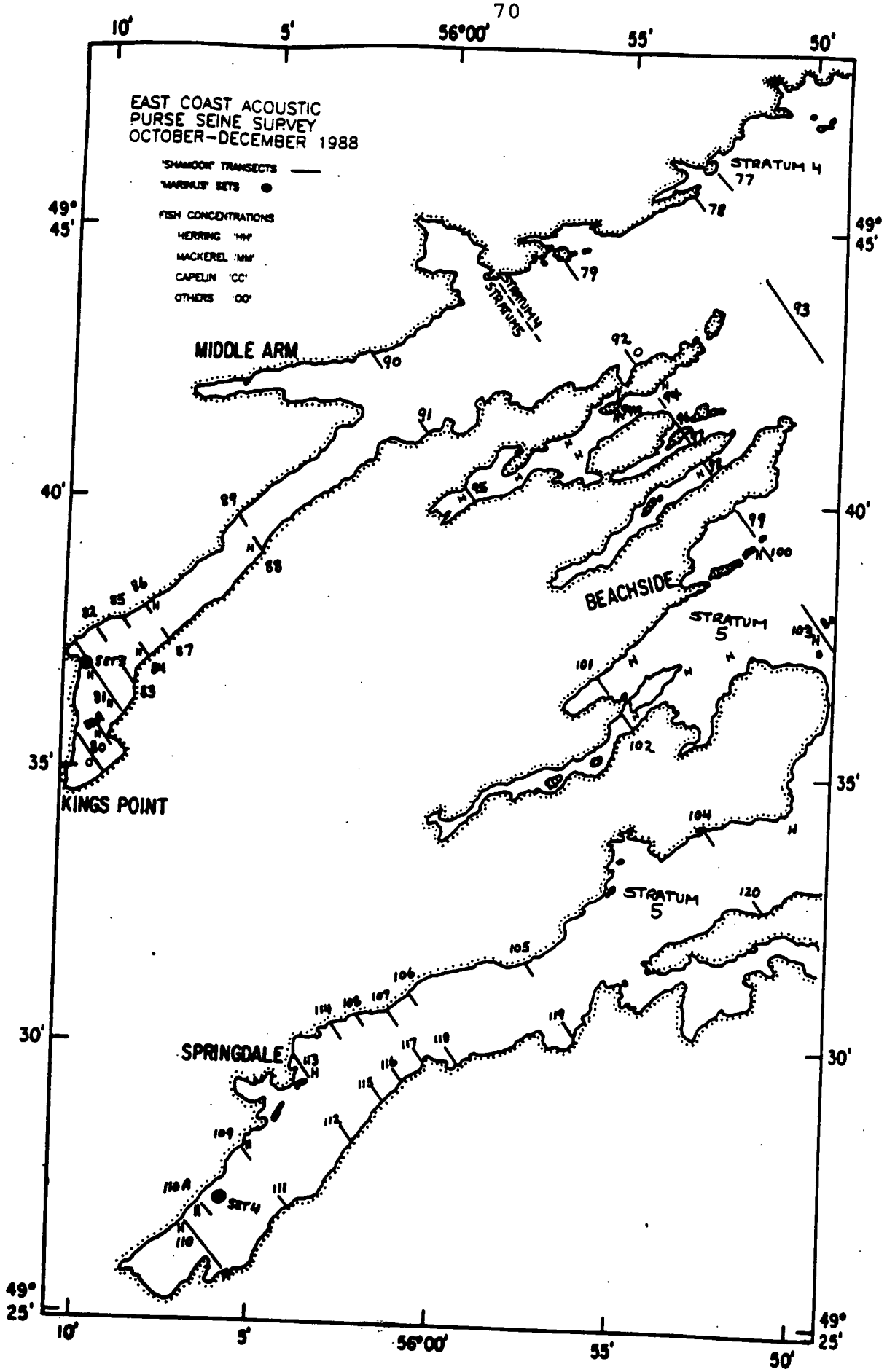
Appendix 1. Transects and set locations, acoustic purse seine survey, White Bay North, 1988.



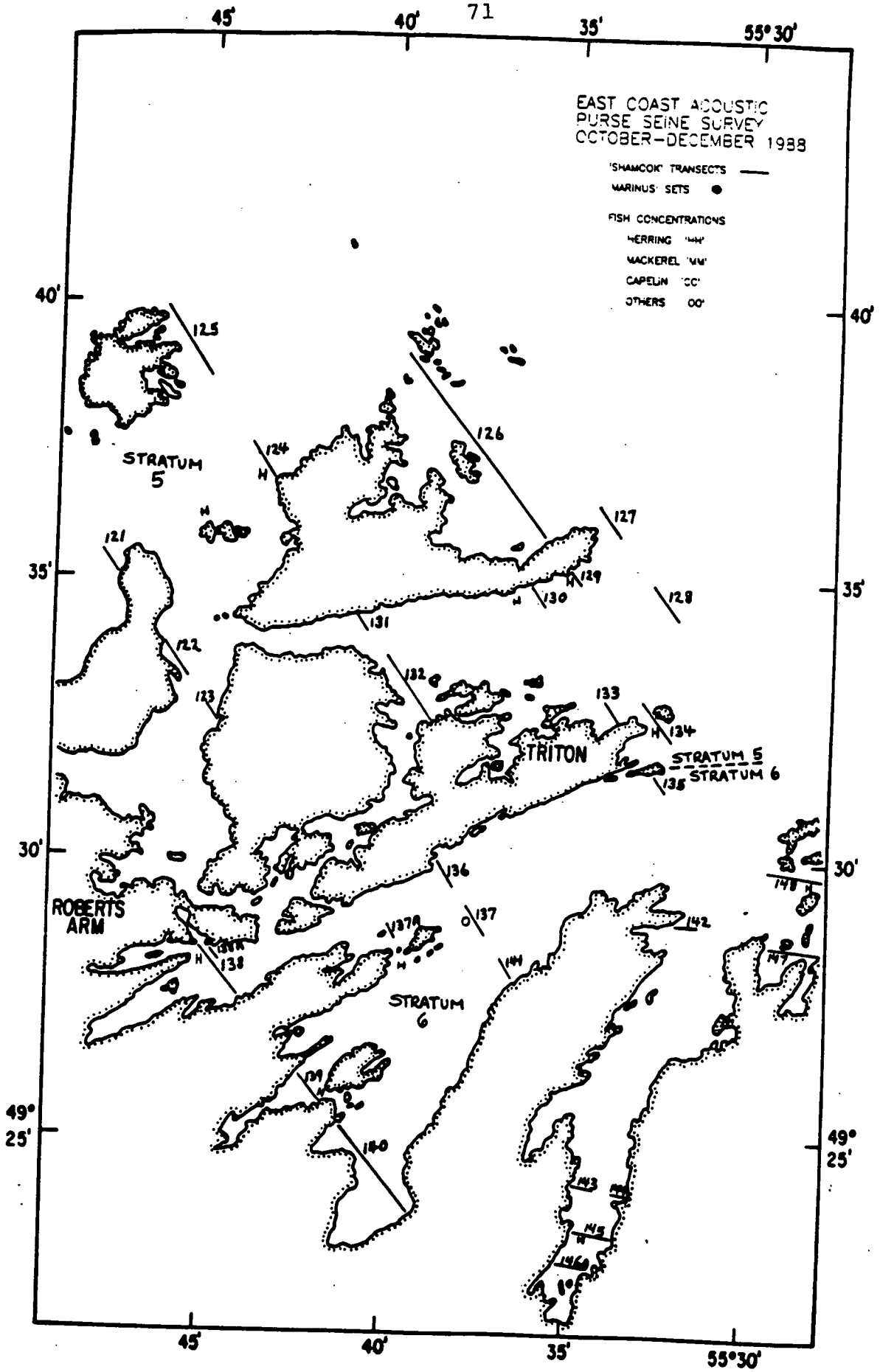
Appendix 2. Transects and set locations, acoustic purse seine survey, inner White Bay, 1988.



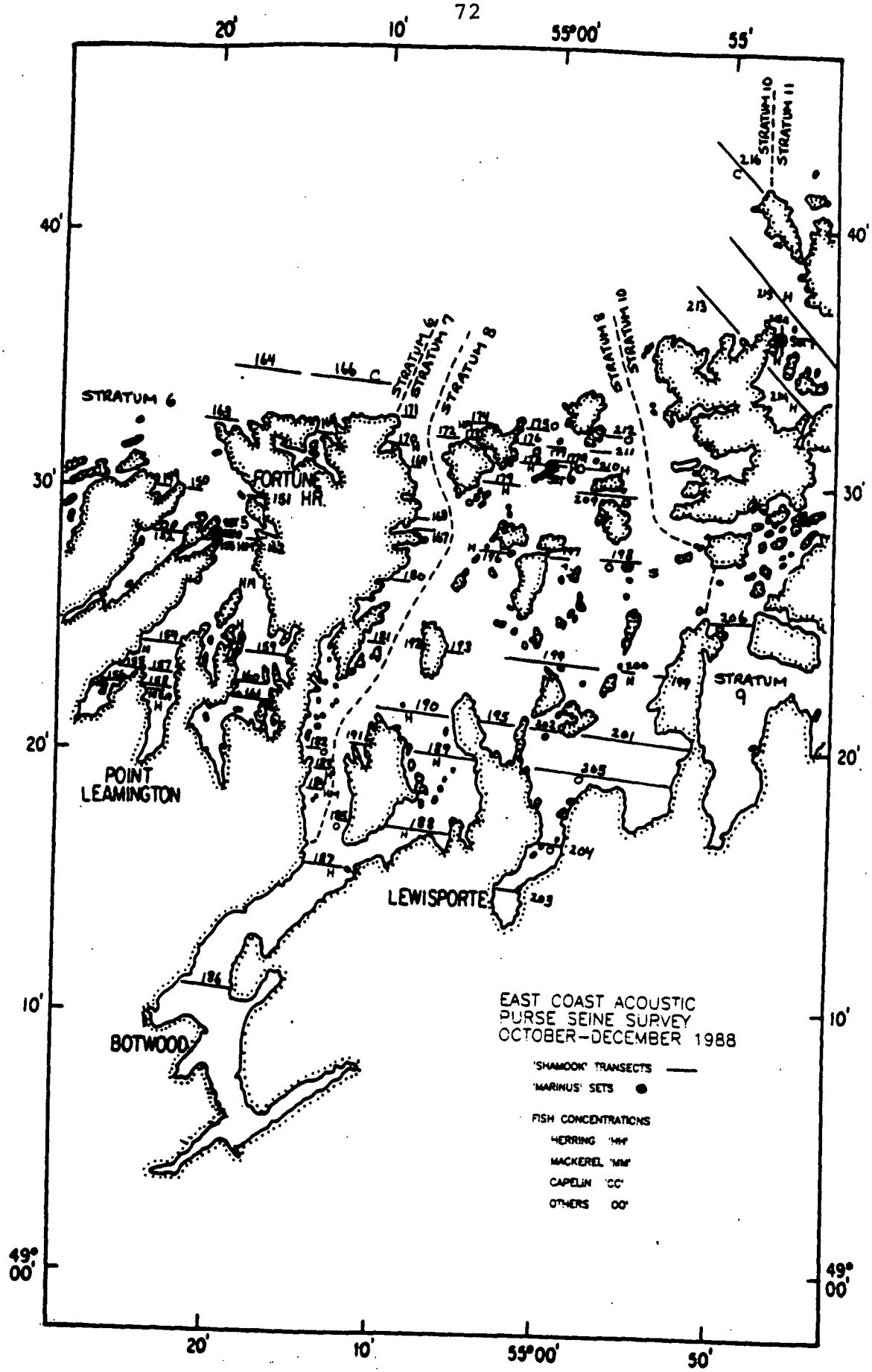
Appendix 3. Transects and set locations, acoustic purse seine survey, White Bay, 1988.



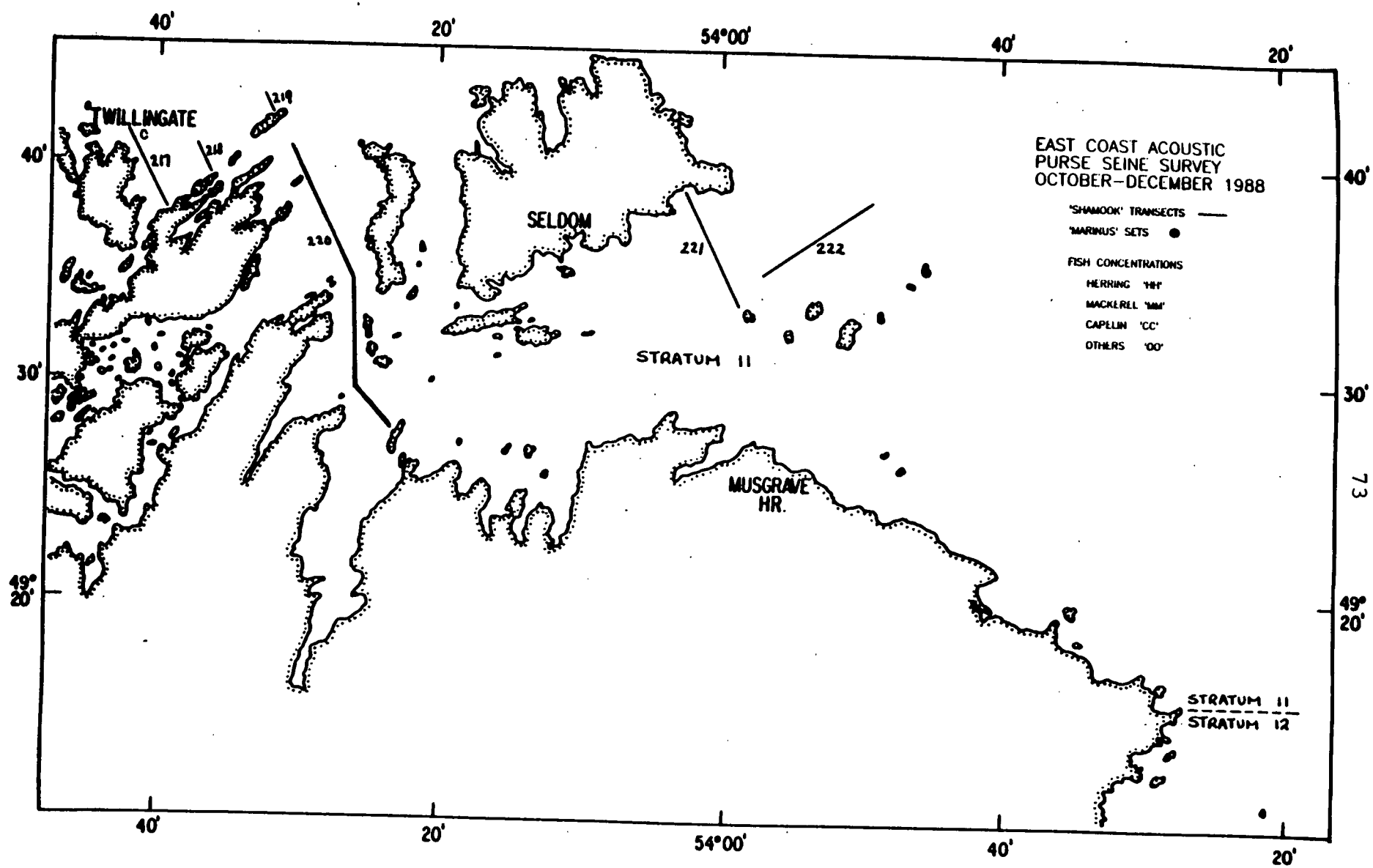
Appendix 4. Transects and set locations, acoustic purse seine survey, Green Bay-Halls Bay, 1988.



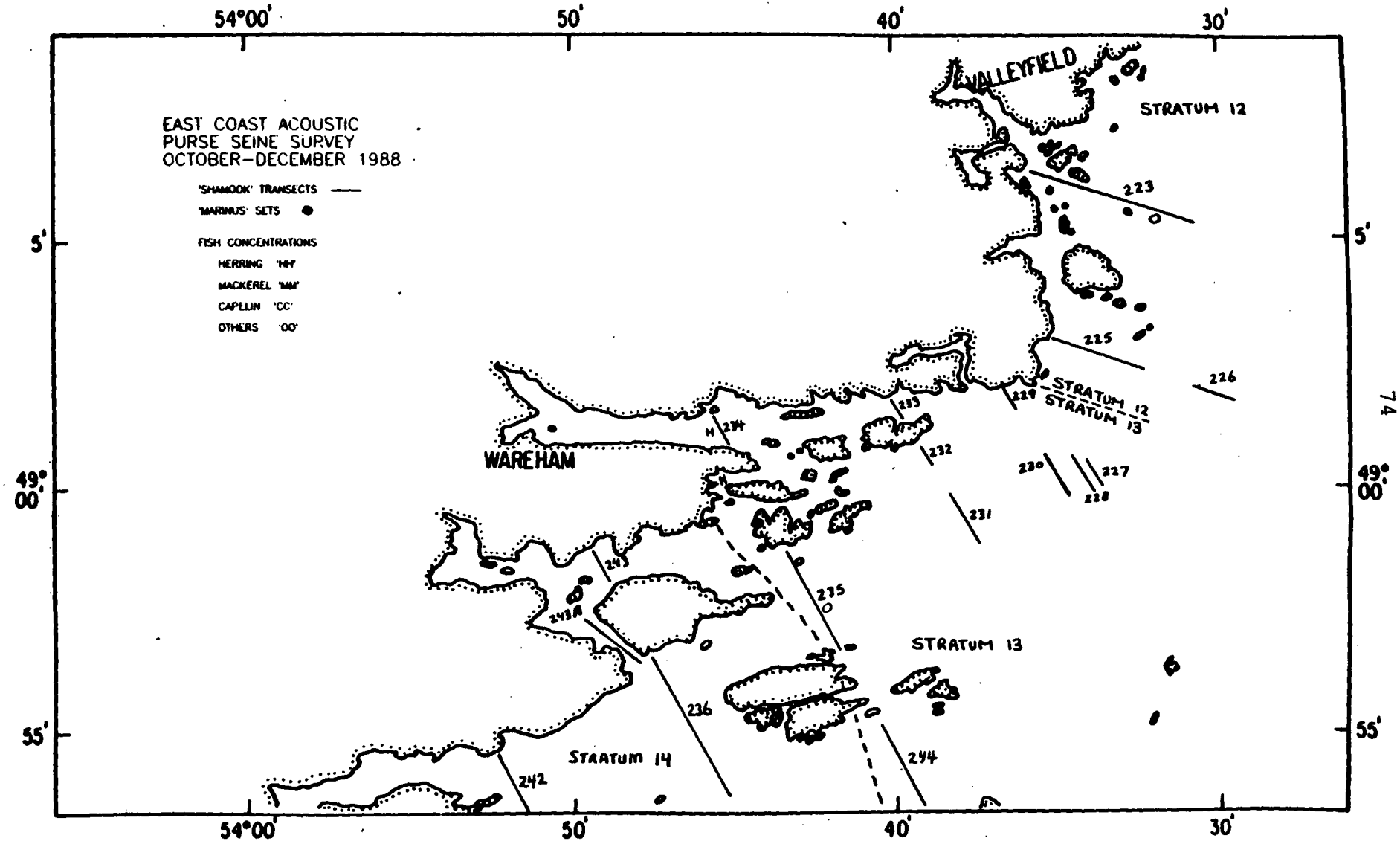
Appendix 5. Transects and set locations, acoustic purse seine survey, Badger Bay-Seal Bay, 1988.



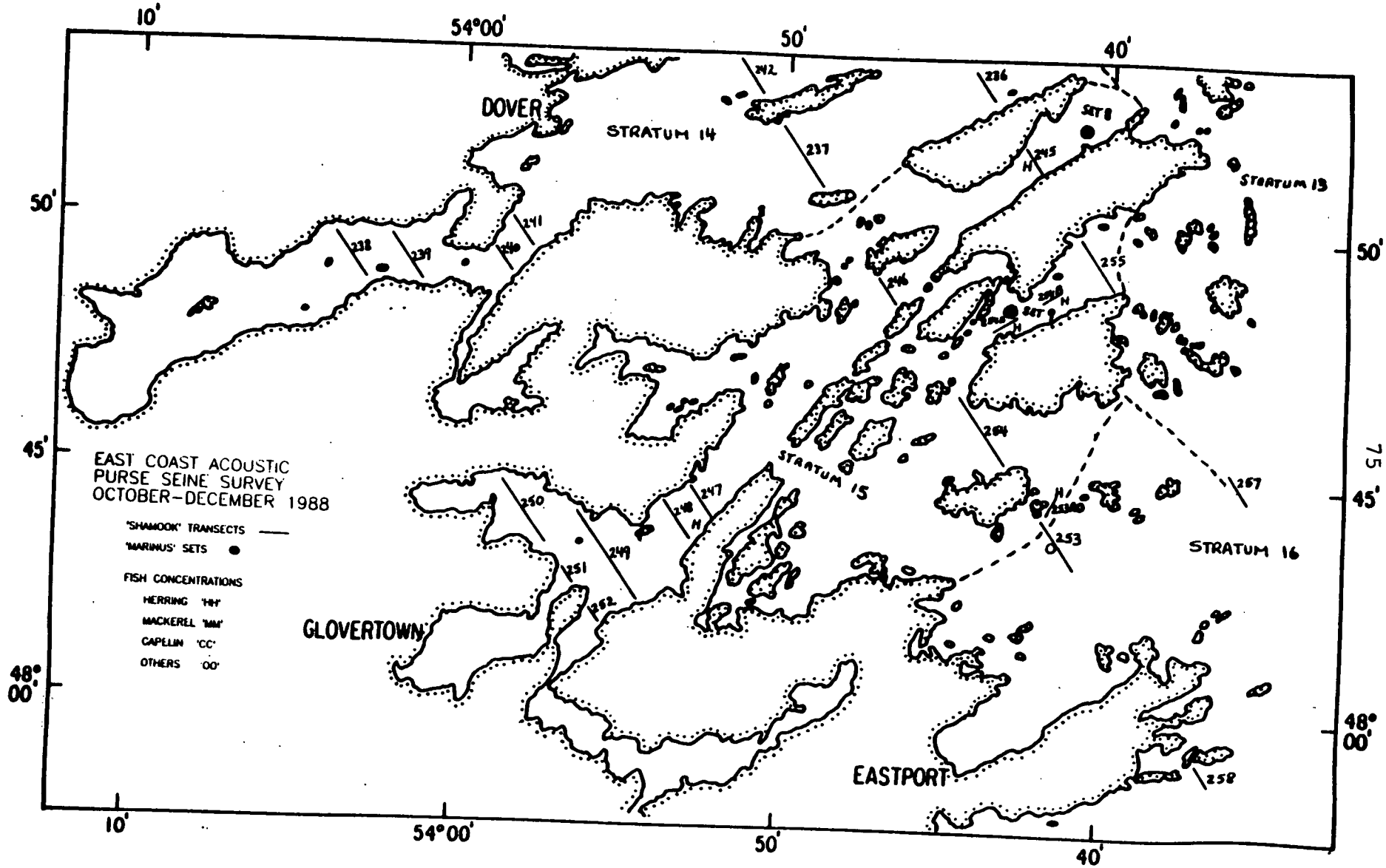
Appendix 6. Transects and set locations, acoustic purse seine survey, New Bay-Bay of Exploits, 1988.



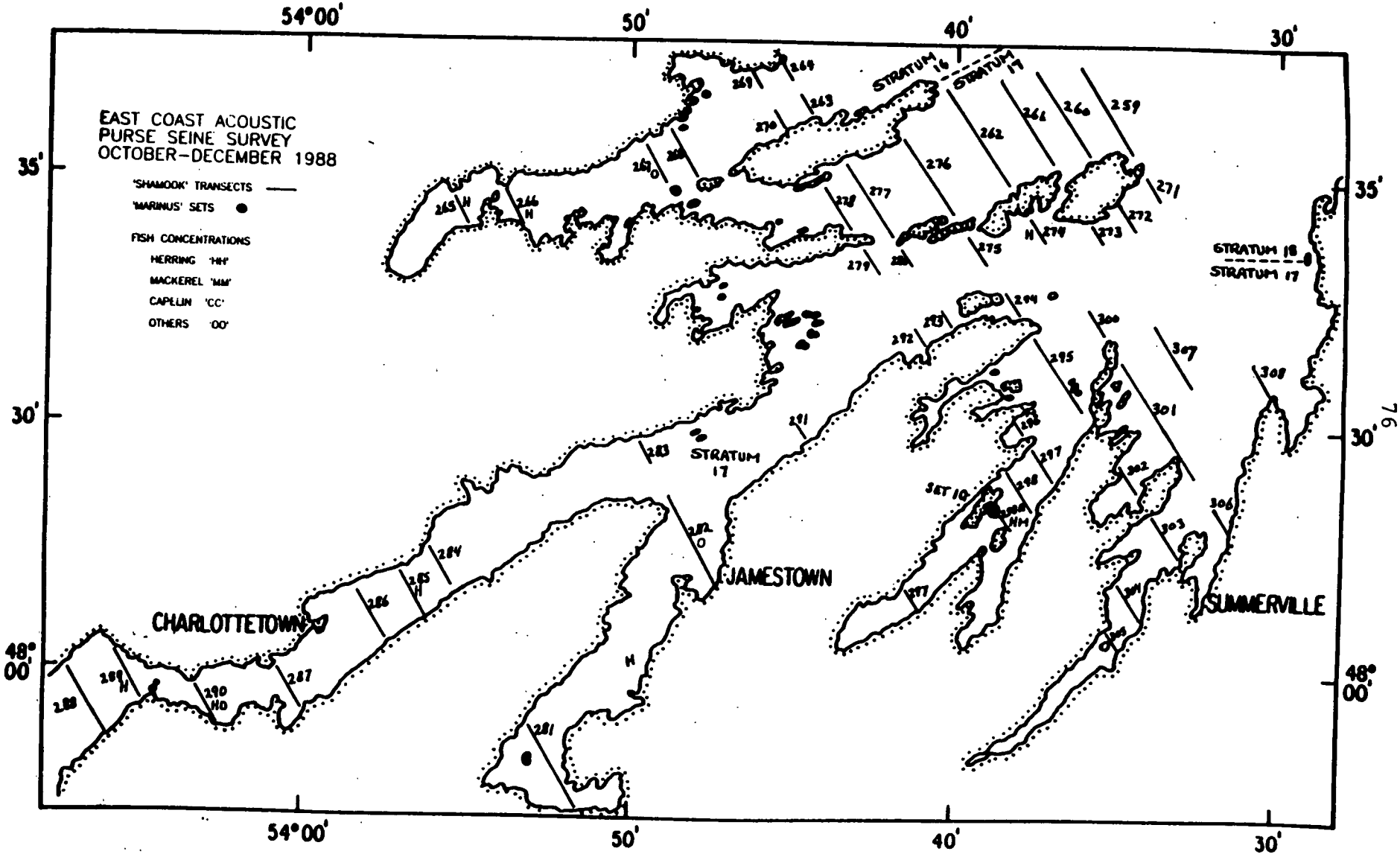
Appendix 7. Transects and set locations, acoustic purse seine survey, Hamilton Sound, 1988.



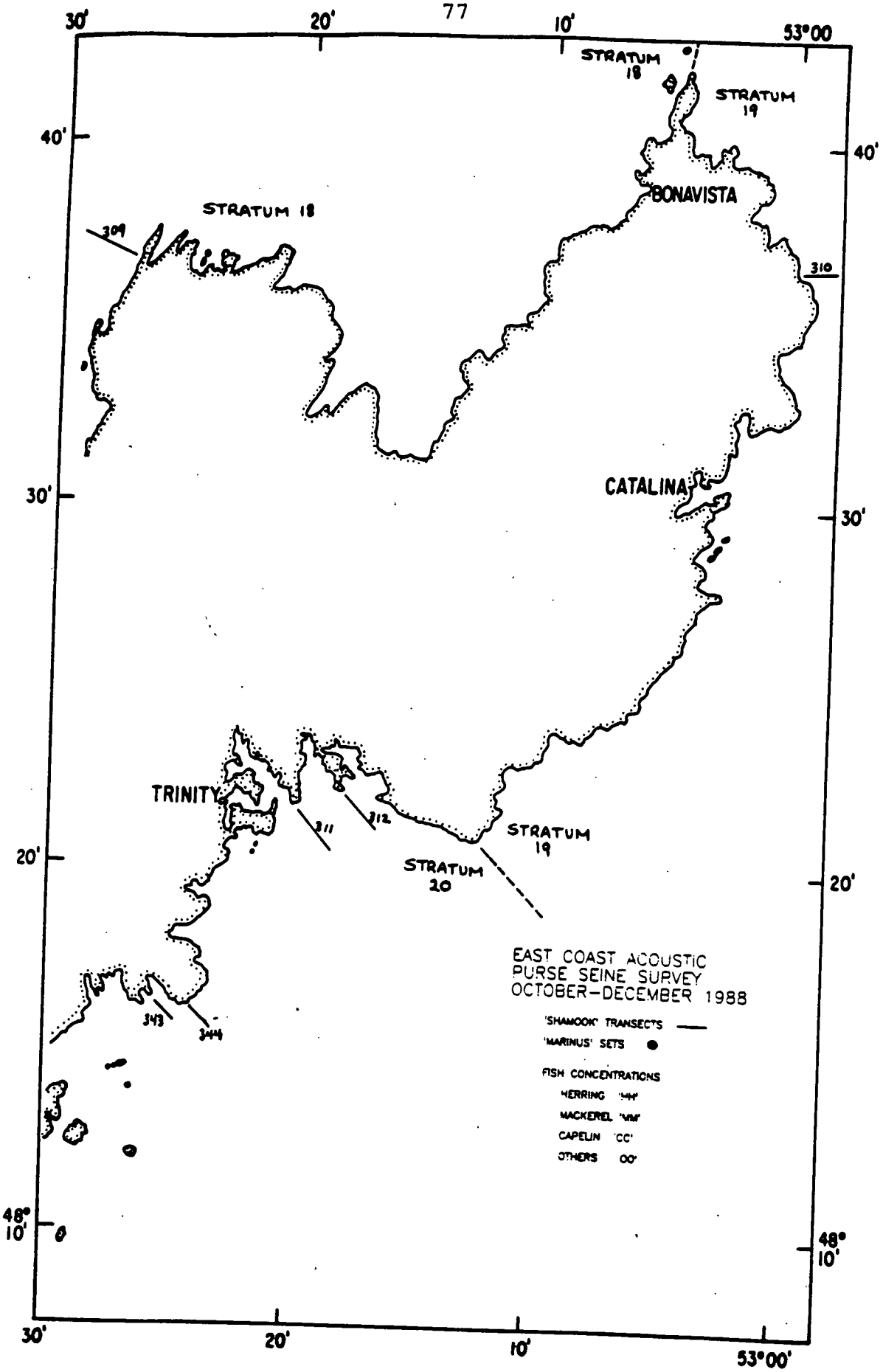
Appendix 8. Transects and set locations, acoustic purse seine survey, Bonavista Bay North, 1988.



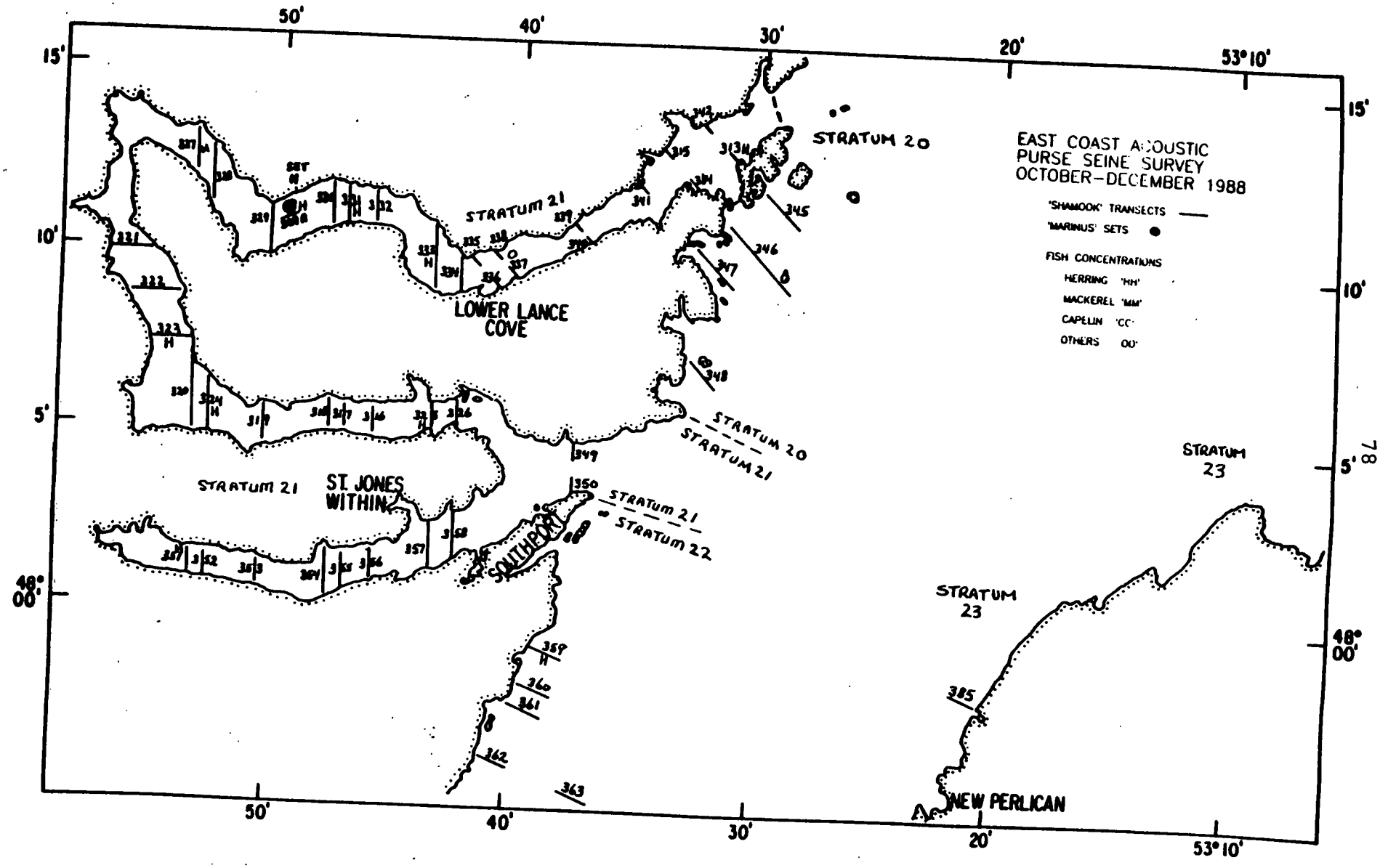
Appendix 9. Transects and set locations, acoustic purse seine survey, Blood Reach, Bonavista Bay, 1988.



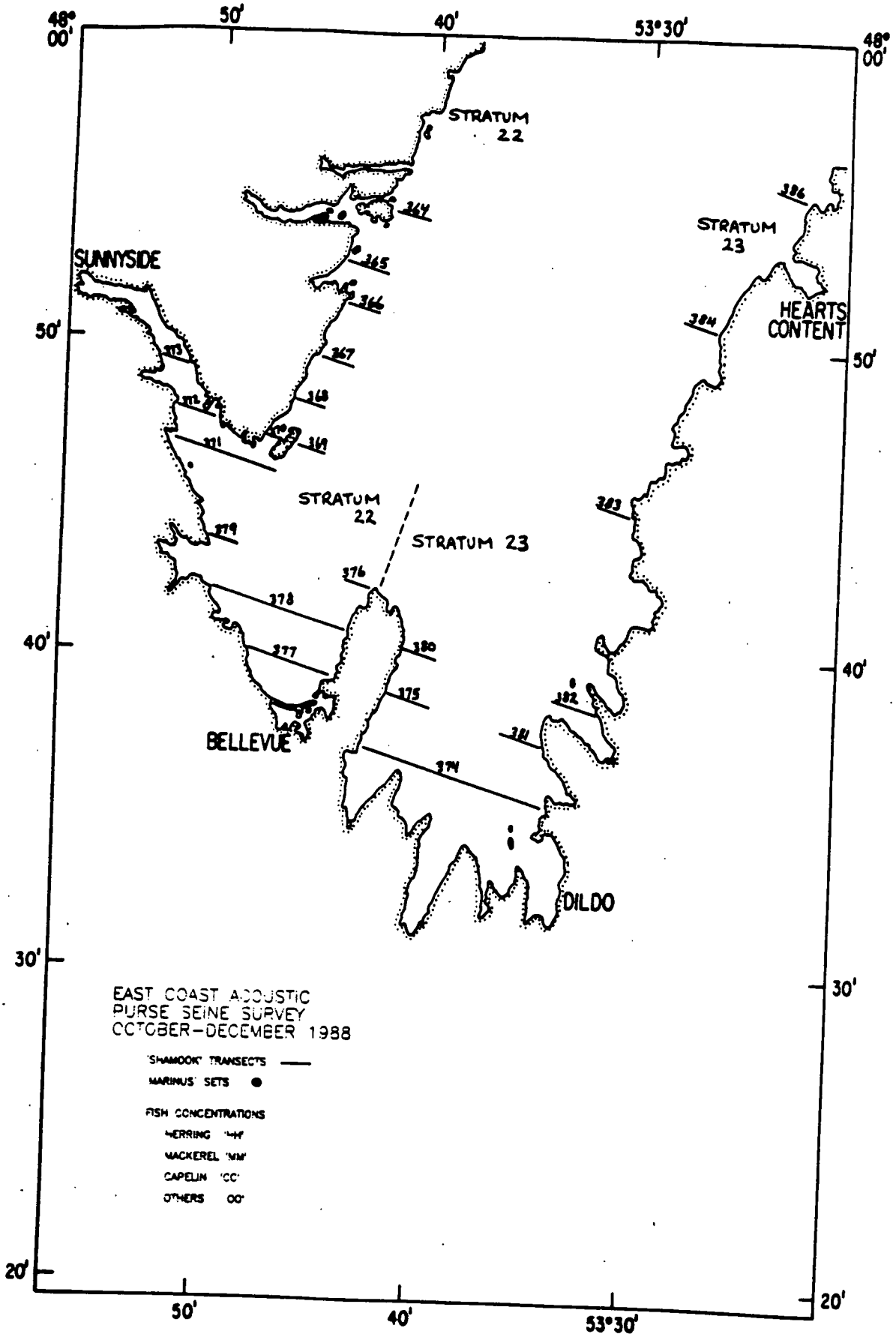
Appendix 10. Transects and set locations, acoustic purse seine survey, Chandlers Reach, Bonavista Bay, 1988.



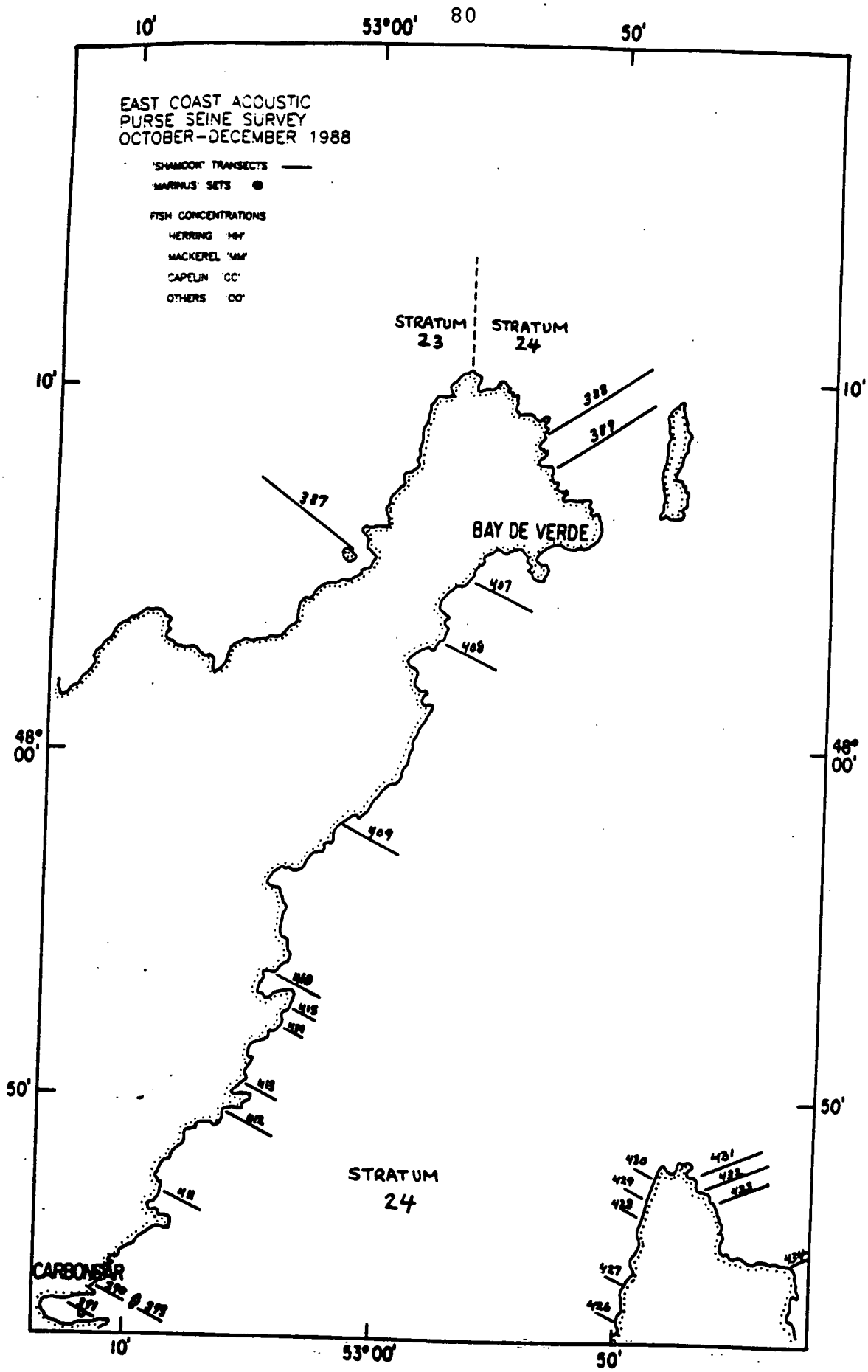
Appendix 11. Transects and set locations, acoustic purse seine survey, Bonavista-Trinity, 1988.



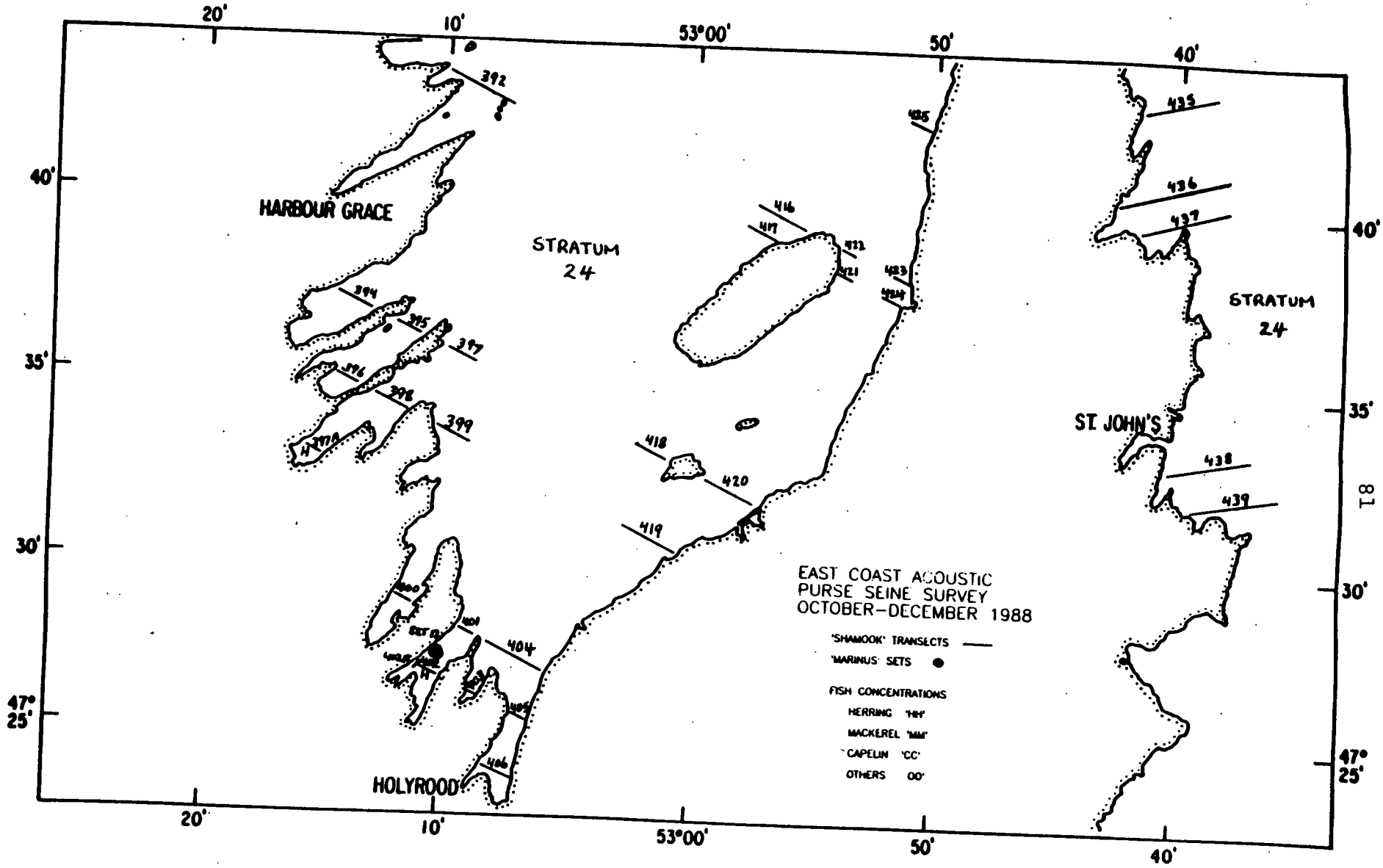
Appendix 12. Transects and set locations, acoustic purse seine survey, Smith and Random Sounds, Trinity Bay, 1988.



Appendix 13. Transects and set locations, acoustic purse seine survey, inner Trinity Bay, 1988.



Appendix 14. Transects and set locations, acoustic purse seine survey, Trinity-Conception Bays, 1988.



Appendix 15. Transects and set locations, acoustic purse seine survey, inner Conception Bay, 1988.

Appendix 16. Formulas for calculating estimates of mean densities, variances, and total biomass for herring acoustic survey.

Given the following:

L - number of strata

l_{hi} - length (n mi) of transect i in stratum h

n_h - number of blocks sampled in stratum h

A_h - surface area (m^2) of stratum h

y_{hi} - biomass (kg) of fish estimated in block i of stratum h

Then:

1) the area (m^2) sampled for transect i in stratum h

$$L_{hi} = (l_{hi} * 1852 \text{ m}) * 926 \text{ m}$$

where due to navigational precision, the minimum distance between transects was predetermined to be 0.5 n mi (926 m)

2) the mean area (m^2) for blocks sampled in stratum h

$$\bar{L}h = \frac{\sum_{i=1}^{n_h} L_{hi}}{n_h}$$

3) the weighting factor for sampled block i in stratum h

$$K_{hi} = \frac{L_{hi}}{\bar{L}_h}$$

to account for differences in the areas of each block sampled, i.e. due to different transect lengths

Appendix 16. Continued...

4) the density (kg/m^2) for block i in stratum h

$$x_{hi} = \frac{y_{hi}}{L_{hi}}$$

5) the mean density (kg/m^2) per unit area for stratum h

$$\bar{x}_h = \frac{\sum_{L=1}^{n_h} (K_{hi} * x_{hi})}{n_h} = \frac{\sum_{L=1}^{n_h} \frac{L_{hi}}{\bar{L}_h} * \frac{y_{hi}}{L_{hi}}}{n_h} = \frac{\sum_{L=1}^{n_h} (y_{hi})}{n_h \bar{L}_h}$$

6) the total fish biomass (t) for stratum h

$$\hat{Y}_h = (A_h * \bar{x}_h)/1000$$

7) the variance estimate for stratum h

$$\hat{O^2}_{Yh} = \frac{\sum_{L=1}^{n_h} K_{hi}^2 (x_{hi} - \bar{x}_h)^2}{n_h (n_h - 1)}$$

8) the total fish biomass (t) for all strata

$$\hat{Y} = \sum_{h=1}^{L} \hat{Y}_h$$

9) the variance estimate for all strata

$$\hat{O^2Y} = \sum_{h=1}^{L} A_h^2 * \hat{O^2Y}_h$$

Appendix 17. Calibration parameters for the BioSonics hydroacoustic system used during the herring acoustic survey, 1988.

105-87-025 / 10-120-1022-001
Sounder / Transducer

BioSonics
SYSTEM CALIBRATION

Customer Name: DEPT. of FISHERIES & OCEAN (Company or Agency) Date: 10-10-88
John Wheeler Project #: P902

BioSonics Contact Person: Cornelia Thomas Calibrator: DS

Echo Sounder
Model # 105 Serial # 105-87-025 Frequency 120 kHz
Rec. Gain (RG) 0 dB Bandwidth .4ms kHz (α) FW
Blanking Distance 0.0 m Calibration Range, (R_{CAL}) 20 m
Total TVG Range 2 — 200 m 20/40 log R cross. dist. 4.1 m

Transducer & Cable Transducer S/N: 10-120-1022-001 Beam width 10°/22°
Cable Length 50' ARMORED / 50 UNARMORED Cable Type D.B. ARMORED / BELDEN Cable S/N 147-85-014 / 141-84-102

Standard Transducer Serial # 125 Type F41
Ts 152.0 dB µPa/Vrms @ 1 meter Ss -203.6 dBv/µPa

Tank Parameters
Transducer separation, (R_s) 1.0 m, Water Temperature 17 °C

CALIBRATION - SYSTEM RECEIVING SENSITIVITY

Transmission Loss, TL = 20 log R + αR = 0.0 dB (R = R_s meters)

TVG gain, G_{TVG40} 52.04 dB (40 Log R_{CAL} + 2 α R_{CAL})
G_{TVG20} 26.02 dB (20 Log R_{CAL} + 2 α R_{CAL})

Voltage into Standard, v_s = .252 V_s = -11.97 dBv (RMS)
Acoustic Level, L = Ts + Vs - TL = 140.03 dB µPa
(at receiving transducer)

Receiver #1 40 log R*
Voltage out of Receiver, v_{det} = 1.63 V_{det} 4.24 dBv

Receiving Sensitivity, Gx = V_{det} - L = -135.79 dBv/µPa @ R_{CAL} meters

$G_1 = G_x - G_{TVG40}$ - RG = -187.8 dBv/µPa @ 1 m

Receiver #1 20 log R*
Voltage out of Receiver, v_{det} = 3.47 V_{det} 10.81 dBv

Receiving Sensitivity, Gx = V_{det} - L = -129.22 dBv/µPa @ R_{CAL} meters

$G_1 = G_x - G_{TVG20}$ - RG = -155.2 dBv/µPa @ 1 m

Appendix 17. Continued ...

BioSonics
SYSTEM CALIBRATION

105-87-023 / 10-120-1022-001
Sounder / Transducer

Page 2 of 2

Simultaneous 20 log R
Voltage out of Receiver, v_{det} = 4.28 V_{det} 12.6 dBv

Receiving Sensitivity, $Gx = V_{det} - L$ = -127.40 dBv/µPa @ R_{CAL} meters

$G_1 = G_x - G_{TVG20} - RG$ = -153.4 dBv/µPa @ 1 m

Receiver #2 40 log R*
Voltage out of Receiver, v_{det} = 2.015 V_{det} 6.09 dBv

Receiving Sensitivity, $Gx = V_{det} - L$ = -133.93 dBv/µPa @ R_{CAL} meters

$G_1 = G_x - G_{TVG40} - RG$ = -186.0 dBv/µPa @ 1 m

Receiver #2 20 log R*
Voltage out of Receiver, v_{det} = 4.38 V_{det} 12.83 dBv

Receiving Sensitivity, $Gx = V_o - L$ = -127.19 dBv/µPa @ R_{CAL} meters

$G_1 = G_x - G_{TVG20}$ = -153.2 dBv/µPa @ 1 m

Gain Difference
40 Log R gain difference G_1 (CH 1) - G_1 (CH 2) = 1.86 dB

CALIBRATION SOURCE LEVEL

Transmission Loss, $TL = 20 \log R_s + \alpha R_s$ = 0.0 dB
Source Level, $SL = V_{so} - Ss + TL$ Pulse Width .4 ms
V_{so} = 20 Log (vrms out of standard)

TRANSMITTER SETTING	v_{out} STANDARD XDUCER		V_{so}	-Ss + TL	SL SOURCE LEVEL
dB	Vpp	Vrms	dBv	dBv	dB µ Pa @ 1 m.
~/A	7.4	2.62	8.35	+203.6	+ 211.9
					+
					+
					+
					+

Comments

Appendix 17. Continued ...

10-12-88

```
***********  BSQUARE  Version 1.02  ***********
                Transducer Beam Pattern
                  Description Program
                  Protocol for IBM-PC
*****************************************************
```

(c) Copyright BioSonics, Inc. September 22, 1987
for
Serial Number 5202-V1.02-87-000

THIS PROGRAM CALCULATES THE MEAN SQUARED BEAM PATTERN AND DIRECTIVITY INDEX FOR A CIRCULAR TRANSDUCER. THIS WEIGHTING FACTOR IS USED IN THE CALCULATION OF THE A CONSTANT FOR SCALING THE ECHO INTEGRATOR. IN ADDITION, THE PROGRAM CALCULATES THE COMPOSITE NARROW/WIDE MEAN SQUARED BEAM PATTERN FOR DUAL BEAM TRANSDUCERS. ALSO FOR DUAL BEAM TRANSDUCERS, THE PROGRAM DESCRIBES THE DECREASE IN THE WIDE BEAM DIRECTIVITY OVER THE MAIN LOBE OF THE NARROW BEAM. FINALLY, THE PROGRAM CALCULATES THE REGRESSION RELATIONSHIP DESCRIBING THE NARROW BEAM DIRECTIVITY, i.e. NARROW BEAM DIRECTIVITY AS A FUNCTION OF ANGLE OFF THE ACOUSTIC AXIS. INPUTS INCLUDE THE ANGULAR INTERVAL BETWEEN dB READINGS, # OF READINGS, OPERATING FREQUENCY, TRANSDUCER TYPE, AND THE DIRECTIVITY FUNCTION VALUES FOR ONE OR BOTH BEAMS.

ENTER THE TRANSDUCER SERIAL NUMBER:

TRANSDUCER 120-1022-001
OPERATING FREQUENCY IS 120 kHz

NARROW BEAM DIRECTIVITY INDEX = 27.94641000
COMPOSITE BEAM DIRECTIVITY INDEX = 25.50776000

NARROW BEAM PATTERN FACTOR [EXPECTED VALUE OF B SQUARED] = .2019713E-02

COMPOSITE BEAM PATTERN FACTOR = .3392999E-02

THE NARROW <Bn> AND WIDE <Bw> BEAM DIRECTIVITIES ARE RELATED AS FOLLOWS:
Bn = (1.3526)*(Bn-Bw)

THE EQUATION RELATING NARROW BEAM DIRECTIVITY TO ANGLE OFF AXIS
IS A POWER FUNCTION OF THE FORM: Y=A*(X**B), WHERE
A = 2.7398
and B = .4290

ANGLE OFF AXIS	NARROW DIRECTIVITY	WIDE DIRECTIVITY
.00	.00	.00
1.00	-.10	-.10
2.00	-.43	-.25
3.00	-1.30	-.40
4.00	-2.55	-.68
5.00	-4.18	-1.13
6.00	-5.88	-1.63
7.00	-5.88	-2.35
8.00	-5.68	-3.08