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Canadian Atlantic Fisheries  
Scientific Advisory Committee

CAFSAC Research Document 85/94

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Comité scientifique consultatif des  
pêches canadiennes dans l'Atlantique

CSCPCA Document de recherche 85/94

## Southeast Coast Newfoundland Herring - 1984 Assessment

by

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## Abstract

Analysis of data collected in 1984 is presented for the two stock complexes 1) St. Mary's-Placentia Bays and 2) Fortune Bay. Landings from the bait fishery in 1984 amounted to a combined total of 127 t. Samples from this fishery and also the research gillnet program indicate that the 1979 year-class dominates in St. Mary's-Placentia Bays but the 11+ group continues to dominate in Fortune Bay. The research purse seine surveys indicate the 1982 year-class to be abundant in St. Mary's-Placentia Bays in 1984 and a predominance of 1982 year-class in Fortune Bay in 1985. Catch rates from the research gillnet program indicated catches were higher in St. Mary's-Placentia Bays but slightly lower in Fortune Bay in 1983. Total mortality coefficients ( $Z$ ) were calculated from the gillnet catch rates but no trends were observed. It was not possible therefore to obtain a best estimate of  $F_t$  with which to initiate cohort analysis. It was possible, however, to calculate total biomass in Fortune Bay using the age structure of samples and measurements of school size taken during the acoustic purse seine survey and a school size-school weight relationship. Calculation of St. Mary's-Placentia Bays biomass was initiated using a north-south cline (southeast and east coast stocks combined) in the size of the 1982 year-class in relation to the 1968 year-class. Trends in biomass, fishing mortality and recruitment were examined.

## Résumé

Une analyse des données recueillies en 1984 est présentée pour les deux complexes de stocks (1) des baies St. Mary's et Placentia et (2) de la baie Fortune. Les débarquements de la pêche à la boîte en 1984 s'élevaient à un total combiné de 127 t. Des échantillons de ces derniers ainsi que le programme de recherche sur la pêche aux filets maillants indiquent que la classe d'âge de 1979 domine dans les baies St. Mary's et Placentia, mais que le groupe de 11+ ans continue de dominer dans la baie Fortune. Les recensements des prises à la senne coulissante indiquent que la classe d'âge de 1982 était abondante dans les baies St. Mary's et Placentia en 1984 et que la classe d'âge de 1982 domine dans la baie Fortune en 1985. Les taux de prises du programme de recherche sur la pêche aux filets maillants ont révélé que les prises ont été plus nombreuses dans les baies St. Mary's et Placentia, mais un peu moins nombreuses dans la baie Fortune en 1983. Les coefficients de mortalité totale ( $Z$ ) ont été calculés à partir des taux de prises aux filets maillants, mais aucune tendance n'a été observée. Il a donc été impossible d'obtenir une estimation optimale de  $F_t$  pour effectuer une analyse de cohortes. On a pu toutefois calculer la biomasse totale dans la baie Fortune à partir de la structure d'âges d'échantillons et de mesures de la taille des bancs pendant le recensement à la senne coulissante acoustique ainsi que d'une relation entre la taille et le poids des bancs. Le calcul de la biomasse des baies St. Mary's et Placentia reposait sur un gradient nord-sud (stocks des côtes est et sud-est combinés) dans la taille de la classe d'âge de 1982 par rapport à la classe d'âge de 1968. Les tendances de la biomasse, de la mortalité due à la pêche et du recrutement ont été examinées.

## Introduction

### 1) Description of Fishery:

Landings from the southeast coast Newfoundland herring stocks (Fig. 1) averaged 30,000 t from 1945 to 1950 and declined to an average of 3450 t from 1958 to 1962 (Templeman 1966). In 1968 landings increased to 21,900 t as a result of a purse seine fishery. Since then there has been a general overall decline (Tables 1-2). The purse seine was the main gear type during the early 1970's and was placed under quota regulation in 1973. In 1980 all gear types were placed under regulation with the purse seine fishery closed in 1981 and the ringnet fishery in 1982. The bar seine fishery was closed in Fortune Bay in 1982 and in St. Mary's-Placentia Bays in 1983. With the quota regulation and resulting closure of mobile gears the proportion of gillnet landings has increased to 100% in recent years. From 1982 to 1984 the commercial gillnet fishery was closed except for fixed gear bait permits and by-catches from the capelin and mackerel fishery.

### 2) Nominal Catches:

TAC's and landings from the combined Fortune Bay and St. Mary's-Placentia Bays are listed below:

	1977	1978	1979	1980	1981	1982	1983	1984
TAC	4400	5000	4400	2700	1400	0	0	0
Catch	3847	3626	4812	1918	702	67	55	127

## Input Data

### 1) Stock Delineation:

As in past assessments the stock complexes considered here are:

1) St. Mary's-Placentia Bays, Areas G&H (3Lg and 3PSc) and 2) Fortune Bay, Area I (3PSn) (Fig. 1).

### 2) Biological Sampling:

Although there has been a reduction in commercial catch in recent years, the trend towards increased sampling continued in 1984 (Table 3). This is a result of 1) the experimental gillnet program which began in 1982, 2) to a lesser extent on research purse seine surveys which began in 1983. and 3) to the slight increase in the commercial gillnet catches in 1984.

Commercial catch-at-age data (Tables 4-5) for 1984 were generated by applying age compositions from the appropriate commercial samples to landings. Where no commercial samples were available, catch-at-age data were generated using research samples collected from commercial mesh size (2 1/2"-2 3/4") gillnets. As in the past the catch matrix has been derived for spring-spawning herring only.

### 3) Acoustic Purse Seine Surveys:

For the second consecutive year an acoustic purse seine (less than 65') survey has been carried out on the two stock complexes. In 1985 one chartered commercial ringnet vessel and the research vessel MARINUS carried out the survey in Fortune Bay, Placentia Bay and St. Mary's Bay. Approximately 2200 mi of cruise track were covered at a speed of 3-5 knots with continuous monitoring of sounder and sonar. Except for some minor variations this year's cruise track was similar to that carried out in February 1984 (Wheeler and Dalley 1984). Detailed observations were made on 58 schools in Fortune Bay, eight sets (none successful for herring) were made in Placentia Bay and no schools were sighted in St. Mary's Bay. Areas of Placentia Bay where herring were caught in 1984 were inaccessible in 1985 due to ice coverage. The survey design and techniques of data collection and analysis were the same as described for the east coast survey. Detailed analyses were available for Fortune Bay only.

### 4) 1984 Age Compositions:

Age compositions were available from three types of samples: 1) commercial gillnet fishery; 2) research gillnet fishery; and 3) research purse seine survey. Age compositions of the commercial weighted catch (Fig. 2) indicate that age group 5 (1979 year-class) is dominant (a change since 1983 when 11+ was dominant) in St. Mary's-Placentia Bays. This year-class is second only to the 11+ group in Fortune Bay. The proportion of fall spawners in the commercial catch has increased from 21.6% to 53% in St. Mary's-Placentia Bays and from 28.0% to 36.9% in Fortune Bay since 1981. This is largely a result of the relative size of the 1979 year-class.

Age compositions from research gillnets (Fig. 3) were similar to the commercial fishery. In St. Mary's-Placentia Bays the 1979 year-class was dominant but not to the extent as in the commercial fishery. The 11+ age group is dominant in Fortune Bay with the 1979 year-class second. There is also a relatively large proportion of fall spawners in both areas.

The main point from the age composition of the acoustic purse seine surveys (Fig. 4) is the dominance of the 1982 year-class in St. Mary's-Placentia Bays in 1984 (no purse seine samples were available from St. Mary's-Placentia Bays in 1985) and in Fortune Bay in 1985. In 1984 the 1980 and 1979 year-classes were dominant in research purse seine catches in Fortune Bay.

The 1982 year-class was dominant in the acoustic survey in 1985 whereas the 1980 and 1979 year-classes were dominant in the 1984 survey. No purse seine samples were available from the St. Mary's-Placentia Bays acoustic survey in 1985. However, the 1982 year-class was dominant in the 1984 survey in that area.

### 5) 1984 Age Specific Weights:

Mean weights at age derived from all samples (both commercial and research) collected from January to June of 1984 are shown in Table 6.

## 6) Abundance Indices:

The research gillnet program initiated in 1982 was continued for a third consecutive year. In 1984 six southeast coast fishermen (Tables 7-8 and Fig. 1) were contracted to fish a fleet of five gillnets ranging in mesh size from 2" to 3", for a period of one month (April to May), to maintain an accurate daily log of catch, and to collect and freeze samples from their catch. Actual catches at age are shown in the appendices.

Total catch from the research gillnet program is shown in Tables 7 and 8. Total catch was higher in three of four locations in St. Mary's-Placentia Bays and lower in one location and higher in the other in Fortune Bay. Total combined catches were up in both stock areas in 1984.

As in 1983 (Wheeler and Dalley 1984) catch per unit effort was examined using 1) the total number of herring caught per fishing day (Tables 9 and 10) and 2) total number of herring caught per days hauled (Tables 11-12). Both of these options yield similar results. Using either of these options the catch rate increased substantially in 1984 in St. Mary's-Placentia Bays (combined) and decreased slightly for Fortune Bay (combined).

## Estimation of Parameters

### 1) Partial Recruitment Rates:

Partial recruitment rates (Table 13) were those used in last year's assessment (Wheeler and Dalley 1984). These were derived to more accurately assess younger age groups and to account for a bait fishery prosecuted entirely by gillnets.

### 2) Calculation of Total Mortality ( $Z$ ):

After examination of the catch-at-age data from the research gillnet program it was decided to calculate Paloheimo (1961)  $Z$ 's for ages 3+ as in most cases it appeared that full recruitment to the research gillnets occurred at age 3. There was no trend in calculated  $Z$ 's for 1982-84 for either of the two options (Tables 14-15) and therefore it was impossible to obtain a best estimate of  $F_t$  with which to fine-tune cohort analysis.

### 3) Calculation of Stock Biomass from Acoustic Surveys:

From the March 1985 purse seine survey in Fortune Bay it was possible to estimate stock biomass according to the steps outlined in Table 16. A total of 99 schools were observed and an area (length x width) of each school calculated from the depth sounder records. Using the relationship derived in the east coast herring assessment (Wheeler et al. 1985) between area and weight, the weight of each school was calculated. The total tons observed was calculated by summing the weights of all schools observed by both vessels. The estimate of total tons observed was then converted to densities based on the area surveyed as determined from the estimate of distance travelled and cruise track width (0.30 km). The

cruise track width was estimated as the distance covered by a sweep of the sonar as set during the survey. Total biomass (t) within 0-90 m of the area surveyed was calculated by prorating the density estimates by areal expansion. Since a significant number of schools were observed outside the 90 m contour, the biomass estimates are considered to be conservative.

## Assessment Results

### 1) Population Numbers at age:

Total population numbers were obtained for Fortune Bay (Table 17) from biomass estimates calculated from the acoustic survey as described above and from the mean weights of fish sampled from the acoustic surveys. These represented the population in March of 1985. To obtain population numbers of the 1982 year-class at age 2 the numbers in March 1985 (age 3) were back-calculated to January 1984. To obtain an estimate of the size of the 1982 year-class at age 2, relative to that of the 1968 year-class, trial cohort analyses were run until population numbers of the 1982 year-class were obtained that approximated the numbers calculated using results from the purse seine survey.  $F_t$  used was 0.0062 and the results indicated that the numbers at age of the 1982 year-class were 33% of the 1968 year-class at age 2.

Similar estimates were not available for St. Mary's-Placentia Bays. Instead the strength of the 1982 year-class for this area was based upon a comparison of the 1982 year-class to the 1968 year-class for the areas acoustically surveyed both along the east coast (Wheeler et al. 1985) and the southeast coast. These comparisons (Table 18) were determined from cohort analysis initiated with the empirical population age structures, back-calculated to the beginning of 1984, as derived from the most recent acoustic survey.

A north-south cline existed in the relationship of the two year-classes for the acoustically surveyed areas; a value of 0.38 was chosen to estimate the 1982 year-class in relation to that of 1968 for St. Mary's-Placentia Bays. Trial runs of cohort analysis were conducted for St. Mary's-Placentia Bays to derive an estimate of  $F_t$  (0.0065) which when combined with the PR historical pattern provided this relationship (0.38) between the two year-classes and stock size estimates at age for 1984.

### 2) Trends in Biomass and Fishing Mortality:

In both stock areas 2+ biomass has increased. In St. Mary's-Placentia Bays the increase is the first since 1972 and is in the order of 63% (Table 19). In Fortune Bay the increase is the first since 1970 and is in the order of 60% over 1983 levels (Table 20). In St. Mary's-Placentia Bays the present 2+ biomass is approximately 30% of maximum historical levels and that in Fortune Bay 17% of maximum historical levels.

With recruitment of the 1979 year-class, 5+ biomass remained approximately the same in 1984 as in 1983 in St. Mary's-Placentia Bays and decreased slightly in Fortune Bay.

Fishing mortalities for both areas in 1979 were the highest that they have been since the mid 1970's. They have declined in both areas since then as a result of reduced TAC's and closure of the fishery.

### 3) Trends in Recruitment:

The 1982 year-class is the most significant one in both areas since 1968. In St. Mary's-Placentia Bays it is approximately 38% the strength of the 1968 year-class and 33% the strength of the 1968 year-class in Fortune Bay.

Although the 1979 year-class is significant in the age composition of the commercial and research gillnet samples, from the cohort analysis done it is only 5% the size of the 1968 year-class at age 5 in St. Mary's-Placentia Bays and 3% the size of the 1968 year-class at age 5 in Fortune Bay. It should be noted however that in excess of 50% of this age group is fall spawners and the percentages mentioned above represent spring spawners only.

## Prognoses

### 1) Catch Projections:

The population vectors, as described above, were projected to 1986, assuming a catch in 1985 of 800 t for St. Mary's-Placentia Bays and 400 t for Fortune Bay. Recruitment was held constant at a level equal to average recruitment for recent years. The catch projections were performed using two options (Table 21) for partial recruitment: 1) combined purse seine and gillnet fishery (Winters and Moores 1977) and 2) gillnet fishery only (Wheeler and Dalley 1984).

Mean weights at age were those derived from samples collected in 1984 (Table 6);  $F_{0.1}$  was assumed to be 0.30. These projections (Tables 22 and 23) show catches for 1986 of approximately 8500 t for a combined purse seine and gillnet fishery and 5600 t for a gillnet fishery only.

### 2) Management Implications:

The same management implications apply to southeast coast Newfoundland herring as outlined in the east coast Newfoundland assessment (J. P. Wheeler et al. 1985.).

## Acknowledgments

We would like to thank all technical staff who were involved in the herring research program and in particular; C. I. Barbour, who retired this year after 35 years of service. Thanks also to senior research technicians, R. Chaulk and M. F. Dawson, and samplers; P. Williams, B. Slaney and J. O'Brien. We would also like to thank M. Hynes for typing the script.

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Table 1. St. Mary's-Placentia Bays herring landings (t), by gear, 1973-84.  
(SMB = St. Mary's Bay; PB = Placentia Bay)

Year	Area	Gear					Total
		Purse seine	Ringnet	Bar seine	Gillnet	Trap	
1973	S.M.B.	734	-	97	95	10	936
	P.B.	4557	-	-	699	39	5295
	Combined	5291	-	97	794	49	6231
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	94	-	95
	Combined	-	-	1	105	-	106

\* provisional

Table 2. Fortune Bay herring landings (t), by gear, 1973-84.

Year	Gear				Total
	Purse seine	Bar seine	Gillnet	Trap	
1973	2053	1117	83	1	3254
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

\* provisional

Table 3. Number of fish sampled from the southeast Newfoundland herring fishery, by area and gear, 1980-84 (research samples in parentheses).  
(G = St. Mary's Bay, H = Placentia Bay, I = Fortune Bay)

Year	Area	Gear type				Total # sampled	Comm. catch (t)
		Trap	Bar seine	Gillnet	Ringnet		
1980	G	-	-	-	250	250	1025
	H	-	-	(50)	2189	2189 (50)	1452
	I	-	250	100	200	550	451
	Total	-	250	100 (50)	2639	2989 (50)	2928
1981	G	-	-	400 (18)	669	1069 (18)	174
	H	-	-	-	300	300	461
	I	-	-	(34)	-	(34)	67
	Total	-	-	400 (52)	969	1369 (52)	702
1982	G	-	-	1196 (439)	-	1196 (439)	10
	H	-	-	(428)	-	(428)	35
	I	-	-	(273)	-	(273)	22
	Total	-	-	1196(1140)	-	1196(1140)	67
1983	G	-	-	(659)	798	798 (659)	12
	H	100	-	(605)	-	100 (605)	27
	I	-	-	(1017)	-	(1017)	15
	Total	100	-	(2281)	798	898(2281)	54
1984	G	-	-	(1110)	223	223(1110)	11
	H	98	-	488 (653)	(136)	586 (789)	95
	I	-	-	466 (612)	(182)	466 (794)	21
	Total	98	-	954(2375)	223 (318)	1275(2693)	127

Table 4. Commercial catch at age for St. Mary's-Placentia Bays, 1966-84.

Age	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
2	1	1	3232	1	476	1	1	77	996	74
3	1066	1	439	629	109	557	207	326	281	2234
4	104	2362	29	54	4434	116	20375	77	233	472
5	114	158	7417	53	59	2112	725	15470	127	172
6	164	302	399	861	76	80	5154	593	14329	1625
7	1912	788	679	67	645	44	366	6760	436	13857
8	1282	1451	953	55	67	252	100	95	6049	146
9	137	407	2836	99	72	13	900	33	138	3391
10	43	85	2577	347	37	22	73	285	57	351
11	993	33	359	143	38	24	76	60	400	100
12	1	754	139	20	22	25	83	62	67	600
13	1	1	3182	8	3	15	86	68	70	103
14	1	1	1	177	1	2	52	70	76	107
15	1	1	1	1	27	1	7	42	79	117
16	1	1	1	1	1	18	3	6	47	121
17	1	1	1	1	1	1	62	2	7	72
18	1	1	1	1	1	1	1	51	2	11
19	1	1	1	1	1	1	1	1	57	3
20	1	1	1	1	1	1	1	1	1	87

Age	1976	1977	1978	1979	1980	1981	1982	1983	1984
2	365	52	30	88	133	1	1	1	8
3	391	1423	175	663	331	193	1	5	9
4	1905	140	1817	279	133	42	2	2	24
5	208	736	123	2264	153	111	3	3	35
6	267	87	597	97	1269	51	8	2	6
7	863	50	64	614	57	338	3	4	3
8	5622	1039	106	86	470	28	14	1	23
9	201	3830	512	66	38	80	4	9	1
10	2256	134	3827	502	238	6	4	1	10
11	286	1526	113	3046	265	37	1	2	1
12	70	194	1291	90	1609	41	5	1	2
13	500	36	164	1028	48	247	6	3	1
14	84	350	27	131	543	7	36	3	3
15	87	57	300	30	69	84	1	19	3
16	95	58	48	230	18	11	12	1	21
17	98	65	50	38	120	11	2	6	1
18	59	66	54	40	20	19	2	1	7
19	9	40	56	43	21	2	1	1	1
20	73	55	80	108	80	3	3	2	3

Table 5. Commercial catch at age for Fortune Bay, 1966-84.

Age	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
2	1	1	6549	515	42383	174	1536	2220	389	2
3	223	89	128	11984	7997	24094	260	924	1333	279
4	13	24764	317	85	10433	6314	19975	67	543	582
5	22	46	48563	187	87	24357	2941	5671	121	112
6	90	49	216	13038	189	1210	10937	454	4574	87
7	66	422	124	188	7312	270	357	1749	117	1490
8	90	450	610	261	241	9314	4458	78	1119	16
9	28	513	770	690	16	137	1054	240	9	142
10	2	358	920	1935	234	153	35	598	117	22
11	17	15	617	884	141	261	80	15	199	63
12	1	123	26	593	64	157	137	34	5	107
13	1	1	212	25	43	71	82	58	11	3
14	1	1	1	204	2	48	37	35	19	6
15	1	1	1	1	15	2	25	16	12	10
16	1	1	1	1	1	17	1	11	5	6
17	1	1	1	1	1	1	9	1	4	3
18	1	1	1	1	1	1	1	4	1	2
19	1	1	1	1	1	1	1	1	1	1
20	1	1	1	1	1	1	1	1	1	1

Age	1976	1977	1978	1979	1980	1981	1982	1983	1984
2	82	28	1	1	25	1	1	1	3
3	15	2114	42	1	16	144	1	5	1
4	318	25	2705	183	3	16	3	2	6
5	228	328	63	3811	69	4	3	3	4
6	129	166	240	15	1122	3	1	2	2
7	11	26	44	165	7	21	2	4	1
8	337	44	141	5	183	2	36	1	2
9	36	189	52	24	1	23	1	9	1
10	187	4	330	1	11	1	5	1	2
11	14	140	5	87	1	2	1	6	1
12	40	10	172	1	26	1	1	1	8
13	67	30	12	45	1	5	1	1	1
14	2	50	37	3	13	1	2	1	1
15	4	1	61	10	1	3	1	2	1
16	6	3	1	16	3	1	1	1	3
17	4	4	4	1	5	1	1	1	1
18	2	3	5	1	1	1	1	1	1
19	1	1	4	1	1	1	1	1	1
20	1	1	2	2	1	1	1	2	4

Table 6. Mean weight at age (g) of southeast coast Newfoundland herring from samples collected in first and second quarters, 1984.

Age	2	3	4	5	6	7	8	9	10	11+
St. Mary's-Placentia Bays	78	177	230	263	301	343	370	372	374	433
Fortune Bay	73	170	221	258	307	333	372	434	401	441

Table 7. Total catch (number of fish), number of days hauled and number of days fished, by community, for research gillnet program, St. Mary's-Placentia Bays.

Year	Community								
	Riverhead			Colinet			Long Harbour		
	Total catch	# Days hauled	# days fished	Total catch	# Days hauled	# days fished	Total catch	# Days hauled	# Days fished
1982	680	19	25	71	26	31	662	19	32
1983	962	24	31	3193	30	36	3142	18	29
1984	2950	37	46	3283	25	31	27357	15	32
Swift Current									
	Total catch	# Days hauled	# Days fished						
1982	481	20	31						
1983	1870	22	30						
1984	818	15	34						

Table 8. Total catch (number of fish), number of days hauled and number of days fished, by community, for research gillnet program, Fortune Bay.

Year	Community					
	Long Harbour			Belle Bay		
	Total catch	# Days hauled	# Days fished	Total catch	# Days hauled	# Days fished
1982	53	25	31	746	25	32
1983	9711	23	29	1162	9	20
1984	5806	23	32	5908	17	25

Table 9. CPUE indices (total number of herring caught per fishing day) for research gillnet program, St. Mary's-Placentia Bays.

Year	Community							
	Riverhead		Colinet		Long Harbour		Swift Current	
	Catch rate	# Days fished	Catch rate	# Days fished	Catch rate	# Days fished	Catch rate	# Days fished
1982	27	25	2	31	21	32	16	31
1983	31	31	89	36	108	29	62	30
1984	64	46	106	31	855	32	24	34
Combined								
			Catch rate		# Days fished			
1982			22		119			
1983			73		126			
1984			317		143			

Table 10. CPUE indices (total number of herring caught per fishing day) for research gillnet program, Fortune Bay.

Year	Community					
	Long Harbour		Belle Bay		Combined	
	Catch rate	# Days fished	Catch rate	# Days fished	Catch rate	# Days fished
1982	2	31	23	32	13	63
1983	335	29	58	20	222	49
1984	181	32	236	25	206	57

Table 11. CPUE indices (total number of herring caught per days hauled) for research gillnet program, St. Mary's-Placentia Bays.

Year	Community							
	Riverhead		Colinet		Long Harbour		Swift Current	
	Catch rate	# Days hauled	Catch rate	# Days hauled	Catch rate	# Days hauled	Catch rate	# Days hauled
1982	36	19	3	26	35	19	24	20
1983	40	24	106	30	175	18	85	22
1984	80	37	131	25	1824	15	55	15
Combined								
			Catch rate	# Days hauled				
1982			23	84				
1983			98	94				
1984			374	92				



Table 12. CPUE indices (total number of herring caught per days hauled) for research gillnet program, Fortune Bay.

Year	Community					
	Long Harbour		Belle Bay		Combined	
	Catch rate	# Days hauled	Catch rate	# Days hauled	Catch rate	# Days hauled
1982	2	25	30	25	16	50
1983	422	23	129	9	340	32
1984	252	23	348	17	293	40

Table 13. Partial recruitment pattern used for southeast coast spring-spawning herring, 1984.

Age	Partial recruitment
2	0.01
3	0.12
4	0.42
5	0.90
6	1.00
7	0.99
8	0.90
9	0.76
10	0.83
11+	0.53

Table 14. Calculation of instantaneous total mortality (Z) from research gillnet program where effort is number of days fished.

Area	Community	Z3+		
		1982-83	1983-84	1982-84
St. Mary's- Placentia Bays	Riverhead	0.09	-0.56	-0.23
	Colinet	-3.44	-0.23	-3.67
	Long Harbour	-1.27	-1.96	-3.45
	Swift Current	-1.16	0.99	-0.25
	Combined	-1.24	-1.13	-2.45
Fortune Bay	Long Harbour	-5.16	0.61	-4.56
	Belle Bay	-0.82	-1.40	-2.09
	Combined	-2.79	0.08	-2.65

Table 15. Calculation of instantaneous total mortality (Z) from research gillnet program where effort is number of days hauled.

Area	Community	Z3+		
		1982-83	1983-84	1982-84
St. Mary's- Placentia Bays	Riverhead	0.11	-0.52	-0.17
	Colinet	-3.45	-0.26	-3.71
	Long Harbour	-1.23	-2.24	-3.69
	Swift Current	-1.03	0.49	-0.63
	Combined	-1.18	-1.27	-2.54
Fortune Bay	Long Harbour	-5.18	0.51	-4.68
	Belle Bay	-1.37	-0.99	-2.26
	Combined	-2.99	0.15	-2.77

Table 16. Calculation of herring biomass, Fortune Bay, from acoustic purse seine surveys conducted in March 1985.

Fortune Bay 1985	
# schools observed	99
tons observed	3970
# km surveyed	2087
mi <sup>2</sup> surveyed	638
t/km <sup>2</sup>	6.2
stock area (km <sup>2</sup> ) (0-90 m)	1262
biomass (t) (0-90 m)	8473

Table 17. Calculation of population numbers at age from weighted age compositions and biomass estimates as derived from acoustic purse seine surveys in Fortune Bay, 1985.

Age	%	#'s x10 <sup>3</sup> (0-90 m)
0	-	-
1	-	-
2	-	-
3	.814	40811
4	.009	451
5	.109	5465
6	.041	2056
7	-	-
8	.005	251
9	.005	251
10	.005	251
11+	.014	702
Total #'s (x10 <sup>3</sup> )		50136
Mean weight (kg)		0.169
Total biomass (t)		8473

Table 18. The relationship between the 1982 and 1968 year-classes from cohort analysis initiated with empirical population estimates derived from the acoustic survey.

Area	F	1968 year-class	1982 year-class	1982:68 year-classes
White Bay-Notre Dame Bay*	0.0500	643292	441336	0.69
Bonavista Bay-Trinity Bay*	0.0110	783111	401213	0.51
St. Mary's Bay-Placentia Bay**	0.0065	360634	135799	0.38
Fortune Bay*	0.0062	162548	53389	0.33

\* from purse seine survey

\*\* interpolated

Table 19. Results of cohort analysis for St. Mary's-Placentia Bays assuming  $F_t = 0.0065$ .  
Herring - St. Mary's-Placentia Bays - Fishing mortalities

Age	Year									
	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
2	.000	.000	.017	.000	.001	.000	.000	.017	.064	.028
3	.023	.000	.022	.004	.009	.002	.009	.033	.082	.200
4	.017	.065	.003	.003	.036	.012	.098	.004	.029	.192
5	.019	.032	.299	.008	.004	.022	.093	.101	.008	.027
6	.020	.064	.105	.051	.014	.007	.067	.103	.127	.141
7	.147	.125	.201	.023	.049	.010	.043	.118	.102	.175
8	.155	.159	.219	.022	.029	.024	.028	.014	.147	.045
9	.079	.067	.528	.032	.037	.007	.112	.011	.025	.115
10	.036	.064	.768	.110	.015	.014	.049	.047	.025	.083
11	.121	.035	.420	.082	.016	.012	.061	.052	.086	.055
12	.040	.127	.204	.036	.016	.013	.052	.065	.075	.181
13	.053	.051	1.198	.016	.007	.014	.055	.054	.097	.159
14	.070	.069	.066	.171	.002	.006	.060	.058	.079	.212
15	.093	.093	.092	.087	.035	.003	.024	.063	.086	.169
16	.127	.127	.127	.125	.117	.030	.011	.026	.093	.185
17	.182	.181	.181	.181	.177	.164	.136	.009	.038	.200
18	.306	.279	.278	.278	.277	.271	.246	.158	.011	.077
19	.513	.574	.498	.498	.497	.493	.477	.417	.266	.021
20	.513	.574	1.198	.498	.497	.493	.477	.417	.266	.212
F5+	.099	.101	.374	.047	.024	.020	.068	.099	.116	.146
	1976	1977	1978	1979	1980	1981	1982	1983	1984	
2	.017	.028	.002	.049	.056	.000	.000	.000	.000	
3	.203	.084	.122	.058	.263	.108	.000	.000	.001	
4	.263	.103	.147	.292	.015	.048	.001	.000	.003	
5	.121	.153	.124	.275	.258	.015	.004	.003	.006	
6	.054	.068	.179	.136	.245	.128	.001	.004	.007	
7	.103	.013	.065	.282	.111	.094	.010	.001	.006	
8	.100	.175	.034	.117	.363	.073	.005	.004	.006	
9	.080	.091	.122	.027	.069	.096	.013	.004	.005	
10	.104	.071	.124	.169	.126	.014	.006	.004	.005	
11	.090	.095	.078	.137	.126	.026	.003	.004	.005	
12	.049	.081	.109	.083	.100	.026	.004	.004	.005	
13	.225	.032	.092	.119	.058	.020	.005	.003	.004	
14	.188	.243	.031	.098	.085	.011	.004	.003	.004	
15	.267	.188	.339	.043	.069	.017	.002	.002	.004	
16	.202	.287	.240	.475	.033	.014	.003	.002	.003	
17	.224	.207	.431	.304	.491	.025	.003	.002	.003	
18	.251	.232	.265	.749	.259	.131	.006	.002	.003	
19	.084	.269	.315	.350	1.254	.037	.009	.003	.002	
20	.267	.287	.431	.749	1.254	.131	.013	.004	.002	
F5+	.103	.101	.120	.159	.132	.030	.003	.002	-.004	

Table 19. Continued...  
Herring - St. Mary's-Placentia Bays - Population numbers and biomass (B<sub>2+</sub> and B<sub>5+</sub>) estimates

Age	Year									
	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
2	13830	27157	210892	16765	360634	31029	13657	4927	17712	2961
3	51727	11322	22233	169739	13725	294832	25403	11181	3964	13600
4	6913	41386	9269	17806	138402	11139	240884	20611	8859	2992
5	6690	5565	31747	7563	14529	109302	9014	178783	16805	7042
6	9233	5374	4414	19281	6144	11842	87578	6724	132377	13644
7	15469	7411	4127	3253	15007	4961	9623	67039	4969	95416
8	9891	10935	5355	2764	2602	11703	4022	7548	48770	3674
9	1992	6938	7640	3522	2213	2070	9354	3203	6093	34456
10	1337	1507	5312	3689	2794	1747	1683	6844	2592	4864
11	9629	1055	1157	2018	2706	2254	1410	1312	5345	2071
12	28	6985	834	622	1522	2181	1824	1086	1020	4014
13	21	22	5037	557	491	1227	1763	1418	833	774
14	16	16	17	1244	449	399	991	1366	1099	619
15	12	12	13	13	859	367	325	764	1055	831
16	9	9	9	9	10	679	299	260	588	792
17	7	7	7	7	7	7	539	242	207	439
18	4	5	5	5	5	5	5	385	197	163
19	3	3	3	3	3	3	3	3	269	159
20	1	1	1	1	1	1	1	1	2	169
B <sub>2+</sub>	26947	25465	40467	42080	62073	79224	85188	73795	61471	50723
B <sub>5+</sub>	16675	14529	19023	12523	14053	35476	34470	67310	57636	47760
	1976	1977	1978	1979	1980	1981	1982	1983	1984	
2	24263	2108	15846	2027	2691	12068	14497	15556	135799	
3	2357	19535	1679	12946	1580	2083	9879	11868	12736	
4	9113	1576	14706	1216	10000	994	1530	8088	9712	
5	2022	5737	1164	10396	743	8067	776	1251	6620	
6	5610	1467	4032	842	6463	470	6504	632	1022	
7	9700	4352	1123	2761	601	4143	339	5318	516	
8	65582	7161	3518	861	1705	441	3087	275	4350	
9	2876	48607	4923	2784	627	970	335	2514	224	
10	25142	2173	36330	3567	2220	479	722	271	2050	
11	3665	18543	1657	26282	2466	1602	387	588	221	
12	1605	2742	13801	1255	18762	1780	1278	316	479	
13	2744	1251	2069	10131	946	13905	1420	1042	258	
14	541	1794	991	1546	7365	731	11161	1157	850	
15	410	367	1152	787	1147	5538	592	9105	945	
16	575	257	249	672	617	877	4458	484	7437	
17	539	385	158	160	342	489	708	3639	395	
18	294	353	256	84	97	171	391	578	2974	
19	124	187	229	161	32	61	123	318	472	
20	128	93	117	137	93	8	48	100	259	
B <sub>2+</sub>	40126	34452	30419	25589	21236	16835	16216	16435	25954	
B <sub>5+</sub>	35820	30896	25362	23100	18313	15291	12798	11032	10873	

Table 20. Results of cohort analysis for Fortune Bay assuming  $F_t = 0.0065$ .  
Herring - Fortune Bay - Fishing mortalities

Age	Year									
	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
2	.000	.000	.052	.015	.340	.032	.224	.332	.023	.001
3	.001	.003	.009	.128	.342	.330	.062	.204	.340	.021
4	.006	.186	.015	.007	.157	.500	.504	.020	.177	.243
5	.012	.028	.673	.011	.009	.665	.460	.258	.046	.050
6	.018	.033	.178	.378	.014	.163	.731	.117	.342	.043
7	.010	.111	.110	.232	.378	.024	.066	.236	.040	.177
8	.021	.087	.231	.356	.526	1.251	.681	.018	.233	.007
9	.010	.161	.210	.445	.033	.656	.423	.066	.003	.042
10	.014	.167	.481	1.268	.264	.489	.341	.454	.042	.008
11	.017	.140	.482	1.288	.258	.531	.515	.239	.266	.028
12	.042	.167	.382	1.298	.264	.511	.597	.430	.117	.223
13	.056	.054	.482	.789	.269	.527	.554	.548	.239	.095
14	.072	.073	.070	1.305	.125	.546	.582	.487	.345	.198
15	.099	.096	.097	.093	.276	.177	.619	.540	.305	.308
16	.129	.136	.132	.133	.127	.580	.126	.618	.319	.246
17	.196	.185	.196	.189	.191	.181	.710	.179	.477	.322
18	.290	.307	.284	.307	.293	.296	.278	.824	.274	.468
19	.505	.529	.579	.514	.577	.537	.547	.498	.496	.487
20	.505	.529	.673	1.305	.577	1.251	.731	.824	.496	.487
F <sub>5+</sub>	.015	.108	.615	.310	.181	.555	.549	.209	.204	.086
Age	Year									
	1976	1977	1978	1979	1980	1981	1982	1983	1984	
2	.004	.021	.001	.002	.027	.001	.000	.001	.000	
3	.012	.153	.039	.001	.040	.216	.001	.002	.001	
4	.030	.025	.299	.241	.004	.051	.006	.002	.003	
5	.141	.039	.082	.915	.134	.006	.012	.008	.006	
6	.075	.145	.036	.025	.773	.008	.002	.010	.006	
7	.007	.019	.052	.031	.015	.027	.006	.009	.006	
8	.055	.034	.139	.007	.044	.005	.059	.004	.006	
9	.019	.040	.051	.031	.002	.007	.003	.019	.005	
10	.071	.003	.090	.001	.018	.002	.002	.004	.005	
11	.006	.069	.004	.031	.001	.004	.003	.003	.005	
12	.023	.005	.114	.001	.011	.002	.002	.003	.004	
13	.212	.021	.008	.039	.001	.003	.002	.003	.004	
14	.085	.242	.033	.002	.014	.001	.001	.003	.004	
15	.197	.055	.525	.011	.001	.004	.002	.002	.003	
16	.307	.222	.072	.250	.004	.001	.002	.002	.003	
17	.257	.346	.518	.096	.115	.002	.001	.002	.003	
18	.370	.313	.998	.233	.131	.030	.002	.002	.002	
19	.453	.320	.910	.542	.385	.188	.038	.002	.002	
20	.453	.346	.998	.915	.773	.216	.059	.019	.002	
F <sub>5+</sub>	.053	.041	.060	.212	.101	.006	.006	.004	-.040	

Table 20. Continued...  
Herring - Fortune Bay - Population numbers and biomass (B<sub>2</sub>+ and B<sub>5</sub>+) estimates

Age	Year									
	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
2	35418	20227	141546	37827	162548	6026	8453	8693	18767	1667
3	197180	28997	16559	109962	30504	94733	4776	5531	5109	15013
4	2260	161236	23660	13442	79186	17738	55760	3675	3692	2977
5	2049	1838	109601	19084	10928	55392	8810	27578	2948	2532
6	5543	1657	1464	45792	15456	8869	23312	4552	17448	2304
7	7373	4457	1313	1003	25694	12483	6166	9190	3316	10146
8	4767	5976	3267	963	651	14420	9976	4725	5941	2609
9	3174	3822	4486	2123	552	315	3379	4134	3798	3852
10	158	2574	2665	2976	1114	437	134	1813	3167	3102
11	1098	127	1783	1349	686	700	220	78	943	2487
12	27	884	91	902	305	434	337	107	50	592
13	20	21	612	51	202	192	213	152	57	37
14	16	16	16	309	19	126	93	100	72	37
15	12	12	12	12	69	14	60	42	50	42
16	9	9	9	9	9	43	9	26	20	30
17	6	7	6	6	6	7	20	7	12	12
18	4	4	4	4	4	4	5	8	5	6
19	3	3	3	3	3	3	3	3	3	3
20	1	1	1	1	1	1	1	1	1	1
B <sub>2</sub> +	37678	45582	48774	41280	48072	42451	28127	16719	14245	11776
B <sub>5</sub> +	7523	6950	31706	20688	16172	25302	15390	14590	11465	8975
	1976	1977	1978	1979	1980	1981	1982	1983	1984	
2	20203	1497	1346	550	1027	1451	3805	1813	53389	
3	1363	16466	1200	1101	449	819	1187	3115	1484	
4	12039	1102	11569	945	901	354	540	971	2545	
5	1910	9569	880	7024	608	735	275	439	793	
6	1971	1358	7538	663	2303	435	598	222	357	
7	1808	1497	961	5954	530	870	354	489	180	
8	6959	1470	1202	747	4726	427	693	288	397	
9	2122	5393	1164	857	607	3703	348	535	235	
10	3025	1704	4244	906	680	496	3011	284	430	
11	2519	2308	1392	3176	741	547	405	2461	232	
12	1979	2050	1763	1135	2522	606	446	331	2009	
13	388	1584	1669	1287	928	2041	495	364	270	
14	27	257	1270	1356	1013	759	1667	404	297	
15	25	20	165	1006	1107	818	621	1363	330	
16	25	17	16	80	815	906	667	507	1114	
17	20	15	11	12	51	664	741	545	414	
18	7	12	9	5	9	37	543	606	445	
19	3	4	7	3	3	6	30	444	495	
20	1	2	2	2	1	2	4	23	362	
B <sub>2</sub> +	11746	11151	10024	8117	6107	4944	5002	4669	8141	
B <sub>5</sub> +	7663	8547	7381	7732	5788	4656	4413	3801	3428	



Table 21. Two partial recruitment options used for stock projections; one based upon a combined purse seine and gillnet fishery and the second for gillnet fishery only.

Area	Age	Option 1	Option 2
St. Mary's Bay - Placentia Bay - Fortune Bay	2	0.2	0.01
	3	0.58	0.12
	4	0.73	0.42
	5	0.90	0.90
	6	1.00	1.00
	7	1.00	0.99
	8	1.00	0.90
	9	1.00	0.76
	10	1.00	0.83
	11+	1.00	0.53

Table 22. 1986 catch projection for St. Mary's-Placentia Bays using the population vector derived from the acoustic survey, a projected catch of 800 t in 1985 and two options of partial recruitment patterns.

Age	Population no.	Population wt.	Fishing mortality	Catch no.	Catch wt.	Residual no.	Residual wt.
<b>Option 1 - Combined purse seine and gillnet fishery:</b>							
2	5000	390	.060	264	21	3855	301
3	4064	719	.174	590	104	2796	495
4	89102	20494	.219	15941	3466	58603	13479
5	8304	2184	.270	1789	470	5190	1365
6	6281	1891	.300	1483	446	3810	1147
7	4252	1459	.300	1004	344	2579	885
8	656	243	.300	155	57	398	147
9	331	123	.300	78	29	201	75
10	2794	1045	.300	660	247	1695	634
11	144	62	.300	34	215	87	38
12	1318	571	.300	311	135	799	346
13	142	62	.300	34	15	86	37
14	308	133	.300	73	32	187	81
15	166	72	.300	39	17	101	44
16	547	237	.300	129	56	332	144
17	608	263	.300	144	62	369	160
18	4791	2974	.300 <sup>3</sup>	1131	490	2906	1258
19	255	110	.300	60	26	154	67
20	2388	1034	.300	564	244	1449	627
TOTAL	131452	34066		24482	6476	85596	21328
<b>Option 2 - Gillnet fishery only:</b>							
2	5000	390	.003	14	1	4081	318
3	4090	724	.036	131	23	3230	572
4	90139	20732	.126	9692	2229	65063	14964
5	8244	2168	.270	1776	467	5152	1355
6	6034	1816	.300	1425	429	3660	1102
7	4067	1395	.297	952	326	2474	849
8	628	232	.270	135	50	392	145
9	319	119	.228	59	22	208	77
10	2725	1019	.249	547	204	1739	651
11	140	60	.231	26	11	91	39
12	1284	556	.213	224	97	850	368
13	139	60	.198	23	10	93	40
14	303	131	.180	45	20	207	90
15	164	71	.162	22	10	114	49
16	543	235	.144	66	29	385	167
17	607	263	.129	67	29	437	189
18	4799	2078	.120	493	213	3485	1509
19	256	111	.108	24	10	188	81
20	2406	1042	.108	224	97	1768	766
TOTAL	131887	33203		15944	4278	93619	23332

Table 23. 1986 catch projection for Fortune Bay using the population vector derived from the acoustic survey, a projected catch of 400 t in 1985, and two options of partial recruitment patterns.

Age	Population no.	Population wt.	Fishing mortality	Catch no.	Catch wt.	Residual no.	Residual wt.
<b>Option 1 - Combined purse seine and gillnet fishery:</b>							
2	1000	73	.060	53	4	771	56
3	808	137	.174	117	20	556	95
4	34184	7555	.219	6116	1352	22483	4969
5	374	97	.270	81	21	234	60
6	4485	1377	.300	1059	325	2720	835
7	1676	558	.300	396	132	1017	339
8	1	0	.300	0	0	0	0
9	205	89	.300	48	21	124	54
10	205	82	.300	48	19	124	50
11	205	90	.300	48	21	124	55
12	572	252	.300	135	60	347	153
13	1	0	.300	0	0	0	0
14	1	0	0.000	0	0	1	0
15	1	0	0.000	0	0	1	0
16	1	0	0.000	0	0	1	0
17	1	0	0.000	0	0	1	0
18	1	0	0.000 <sup>5</sup>	0	0	1	0
19	1	0	0.000	0	0	1	0
20	2	1	0.000	0	0	1	1
TOTAL	43722	10314		8102	1974	28507	6668
<b>Option 2 - Gillnet fishery only:</b>							
2	1000	73	.003	3	0	816	60
3	818	139	.036	26	4	646	110
4	34905	7714	.126	3753	829	25194	5568
5	370	96	.270	80	21	231	60
6	4203	1290	.300	992	305	2549	783
7	1560	519	.297	365	122	949	316
8	1	0	.270	0	0	0	0
9	193	84	.228	36	16	126	55
10	197	79	.249	40	16	126	50
11	195	86	.231	37	16	127	56
12	567	250	.159	76	33	396	175
13	1	0	0.000	0	0	1	0
14	1	0	0.000	0	0	1	0
15	1	0	0.000	0	0	1	0
16	1	0	0.000	0	0	1	0
17	1	0	0.000	0	0	1	0
18	1	0	0.000	0	0	1	0
19	1	0	0.000	0	0	1	0
20	2	1	0.000	0	0	1	1
TOTAL	44018	10334		5407	1362	31167	7234

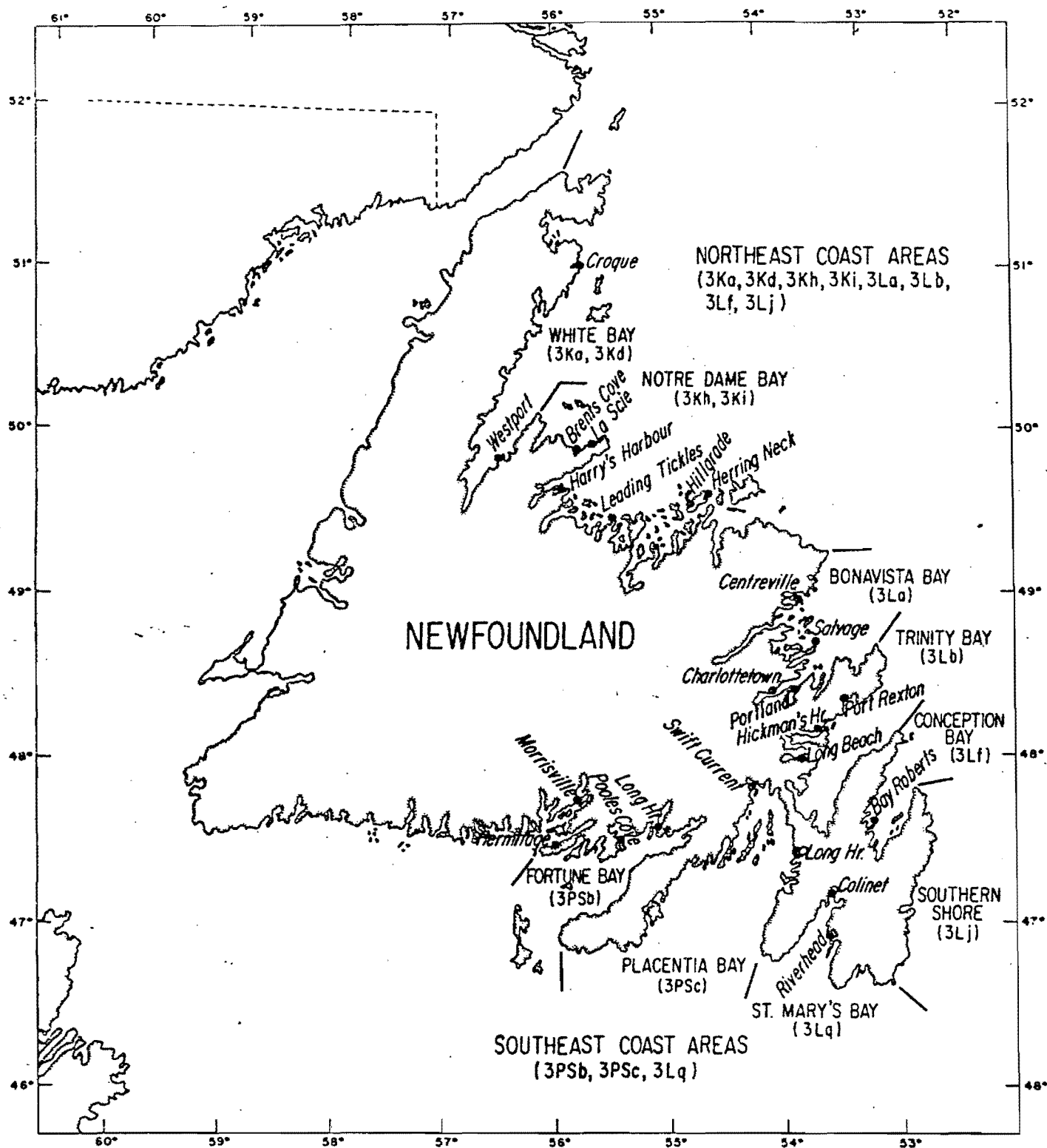


Fig. 1. Map of Newfoundland showing northeast and southeast coast areas.

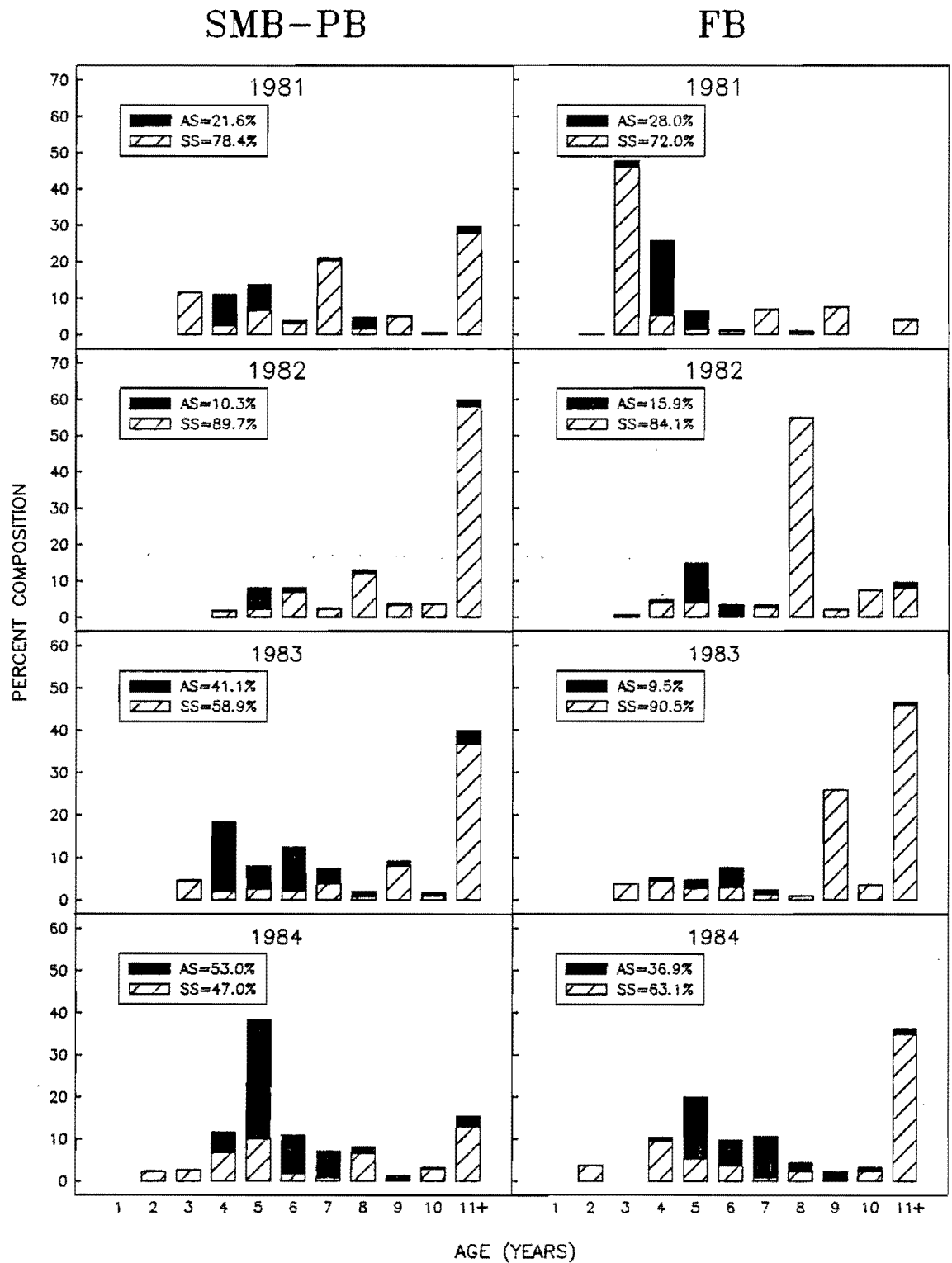


Fig.2. Age composition of herring from commercial fishery, St. Mary's Bay – Placentia Bay, and Fortune Bay, 1981–84.

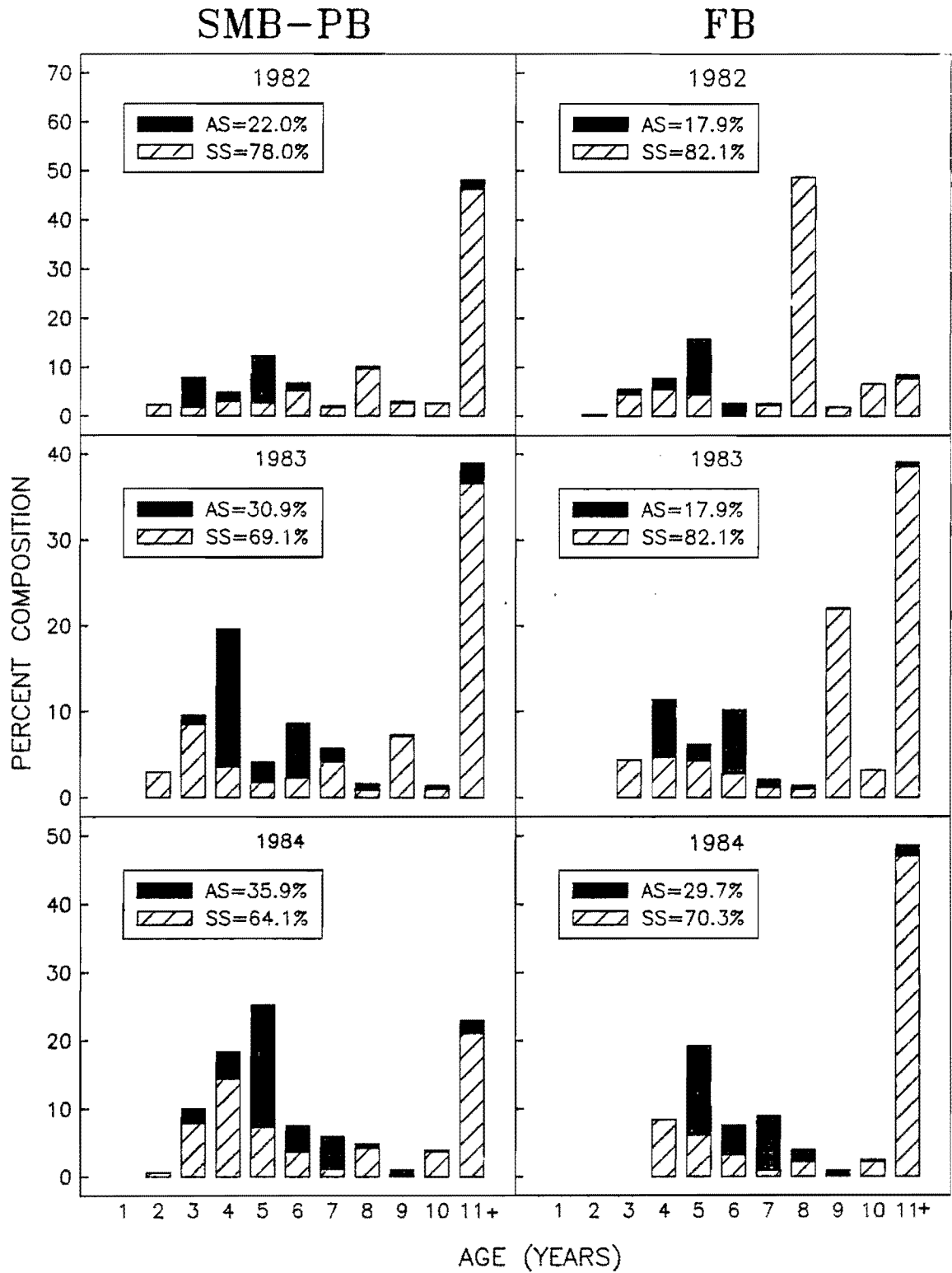


Fig.3. Age composition of herring from research gillnets, St. Mary's - Placentia Bays and Fortune Bay, 1982-84.

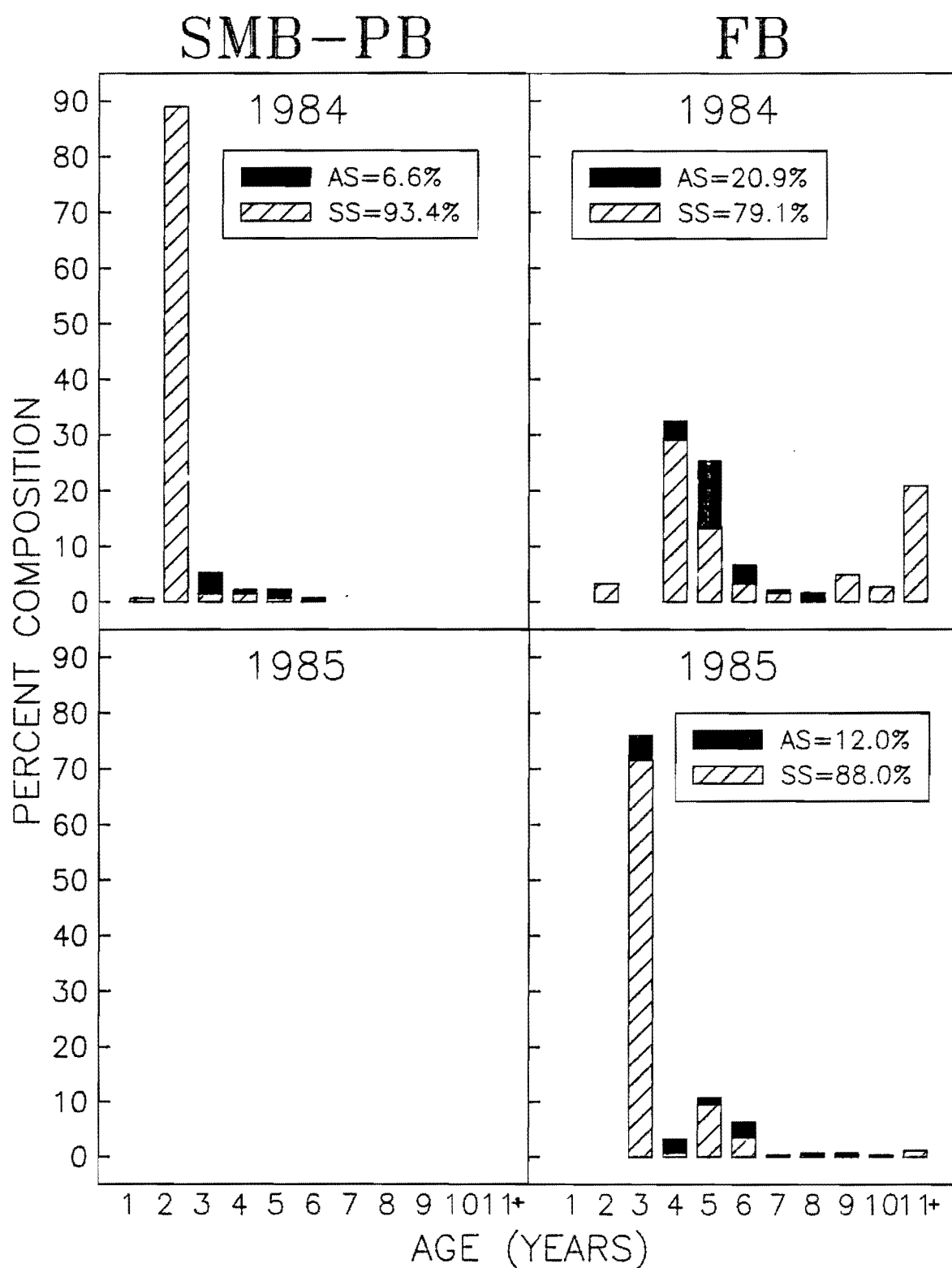


Fig.4. Age composition of herring from acoustic purse seine survey samples, St. Mary's - Placentia Bay, and Fortune Bay, 1984-85.

Appendix 1. Actual catch at age (numbers of herring) from research gillnets, by area and community.

Area	Community	Age	Year		
			1982	1983	1984
St. Mary's- Placentia Bays	Swift Current	1	0	0	0
		2	3	0	5
		3	2	389	28
		4	11	88	110
		5	6	32	124
		6	16	72	29
		7	19	57	40
		8	63	29	58
		9	21	193	7
		10	21	22	63
		11+	320	990	354
		C3+	479	1872	813
		C4+	477	1483	785
St. Mary's- Placentia Bays	Long Harbour	1	0	0	0
		2	0	0	66
		3	73	997	2727
		4	89	466	3627
		5	66	0	6390
		6	141	0	2212
		7	0	391	2914
		8	131	0	988
		9	23	391	595
		10	16	0	1145
		11+	124	898	6693
		C3+	663	3143	27291
		C4+	590	2146	24564



Appendix 2. Actual catch at age (numbers of herring) from research gillnets, by area and community.

Area	Community	Age	Year		
			1982	1983	1984
St. Mary's- Placentia Bays	Combined	1	0	0	0
		2	47	337	99
		3	122	2091	3351
		4	135	899	5270
		5	133	141	7872
		6	226	252	2762
		7	19	716	3205
		8	267	76	1359
		9	58	952	652
		10	47	90	1427
		11+	845	3625	8411
		C3+	1852	8839	34309
		C4+	1730	6748	30958
Fortune Bay	Long Harbour	1	0	0	0
		2	0	0	0
		3	3	602	0
		4	2	601	256
		5	7	729	757
		6	0	250	458
		7	2	141	431
		8	32	113	271
		9	0	2988	58
		10	6	453	197
		11+	4	3836	3378
		C3+	56	9713	5806
		C4+	53	9111	5806