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Southeast Coast Newfoundland Herring - 1983 Assessment

by

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Abstract

Analysis of data collected in 1983 is presented for the two stock complexes 1) St. Mary's-Placentia Bays and 2) Fortune Bay. Landings from the bait fishery in 1983 amounted to a combined total of only 55 tons. Samples from the bait fishery showed that age 11+ fish continue to dominate in both stocks with modest increases in the proportion of ages 4-6 (particularly fall spawners) in St. Mary's-Placentia. Samples from the research gillnet program showed similar results except that the proportion of younger age groups was higher for both stocks. Limited sets from a purse seine survey showed significant concentrations of 1982 yearclass in St. Mary's-Placentia Bays but a predominance of 1979-80 yearclasses in Fortune Bay. Catch rates from the research gillnet program increased in both areas in 1983. Total mortality coefficients (Z) were calculated but no trends were observed. It was not possible therefore to obtain a best estimate of F_t with which to run cohort analysis. However, trial cohort runs were conducted using two options of F_t:F_t = 0.028 which was felt to reasonably reflect fishing mortality in 1983, and F_t = 0.056 which was felt to provide an upper bound to the probable fishing mortality in 1983. Trends in biomass, fishing mortality, and recruitment were examined and management considerations are provided for 1984 and 1985.

Résumé

On présente l'analyse de données prélevées en 1983 concernant deux stocks de poissons : 1) baie Sainte-Marie et baie de Plaisance et 2) baie de Fortune. Les débarquements de poissons résultant de la pêche pour la boëtte s'élevaient en 1983 à un total combiné de 55 tonnes seulement. Des échantillons de la pêche pour la boëtte ont révélé que les poissons âgés de 11 ans et plus continuent de dominer dans les deux stocks et qu'il y a une légère augmentation de la proportion des poissons âgés de 4-6 ans (surtout des reproducteurs d'automne) dans les baies Sainte-Marie et de Plaisance. Des échantillons provenant du programme de recherche sur la pêche au filet maillant ont donné des résultats semblables, sauf que la proportion des groupes d'âges plus jeunes était plus élevée dans les deux stocks. Des ensembles limités tirés d'un relevé concernant la pêche à la senne coulissante ont révélé des concentrations importantes de la classe d'âge 1982 dans les baies Sainte-Marie et de Plaisance, mais une prédominance des classes d'âge 1979-1980 dans la baie de Fortune. Les taux de capture dans le cadre du programme de recherche sur la pêche au filet maillant ont augmenté dans les deux régions en 1983. Les coefficients de mortalité totale (Z) ont été calculés, mais aucune tendance n'a été observée. Par conséquent, il n'a pas été possible d'obtenir une meilleure estimation de F_t pour faire une analyse par cohorte. Deux essais d'analyses par cohorte ont été fait en utilisant deux valeurs de F_t : 1) F_t = 0,028 que l'on pense être une estimation raisonnable de la mortalité due à la pêche en 1983, et 2) F_t = 0,056 que l'on estime représenter la limite supérieure de la mortalite probable due à la pêche en 1983. On a examiné les tendances en ce qui a trait à la biomasse, à la mortalité due à la pêche et au recrutement et on a indiqué des mesures de gestion pour 1984 et 1985.

Introduction

Southeast coast herring comprise two management units: 1) Fortune Bay and 2) St. Mary's-Placentia Bays (Fig. 1). These stocks have traditionally been very productive on a sporadic basis. Landings from the stocks averaged 30,000 t from 1945-50 and declined to an average of 3450 t from 1958-62 (Templeman 1966). In 1968 landings again increased to 21,900 t as the result of a purse seine fishery. Since then there has been a general overall decline in landings to less than 100 t in 1982-83 (Tables 1 and 2). The purse seine was the main gear type during the early seventies. It was placed under quota regulation in 1973. In 1980 all gear types were placed under regulation with the purse seine fishery being closed in 1981, and the ring net in 1982. The ring net and purse seine fisheries are similar except for the size of boats used, less than 65 feet for the ring net, greater than 65 feet for purse seine. The purse seine only has been executed in Fortune Bay but both have been used in St. Mary's-Placentia. 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 increased from 13% to 100% in St. Mary-Placentia Bays from 1973-83 and from 3% to 100% in Fortune Bay for the same time period. In 1982 and 1983 the commercial gillnet fishery was closed except for fixed gear bait permits and limited by-catches from the capelin and mackerel fishery. TACs and landings are listed below for St. Mary's-Placentia Bays:

	1977	1978	1979	1980	1981	1982	1983
TAC (t)	3400	4000	3400	2500	1200	0	0
Catch (t)	3268	3527	3617	2477	635	45	39

and Fortune Bay:

	1977	1978	1979	1980	1981	1982	1983
TAC (t)	1000	1000	1000	200	200	0	0
Catch (t)	579	999	1195	451	67	22	16

Research Purse Seine Charter

Two commercial ringnet (<65 ft) vessels were chartered for 2-3 weeks in February 1984. Approximately 1200 miles of cruise track (Fig. 2-5) was covered in St. Mary's-Placentia and Fortune Bays, at a speed of 4 knots with continuous monitoring of both sonar and sounder. There were only two successful purse seine sets, one in Long Harbour, Fortune Bay which consisted of mixed age groups of herring: 5% 1982 yearclass, 70% 1979-80 yearclass, and 25% 1968 yearclass. The other set in St. Lawrence consisted of 98% juvenile herring, 1982 yearclass. Since there were no research purse seine charters prior to 1984, there are no comparative catches. The survey was conducted in February 1984 and the results will be incorporated in next year's assessment.

Input Data and Assessment Parameters

1) Age Composition

Although there has been a reduced commercial catch in recent years, the number of herring sampled in 1982 and 1983 has increased (Table 3). This is a result of the experimental gillnet program which began in 1982.

The commercial catch-at-age data for the two stocks were re-examined for 1982-83. Where no commercial samples were available, catch-at-age data were generated using research samples collected from commercial mesh size (2½ and 2¾") gillnets (Tables 4-6). For Fortune Bay, a catch matrix was derived for spring-spawning herring only; for Placentia Bay-St. Mary's Bay, catch-at-age data were compiled both for spring and autumn spawning herring. In past assessments of these stocks, analyses have been confined to the spring-spawning components only since in most years they account for >85% of the commercial catch (Tables 4-6). Similarly, in this assessment, cohort analysis was conducted for spring-spawners only, except for the analysis of Placentia Bay-St. Mary's Bay herring presented in Appendices 1-5.

Age compositions from the commercial fishery for the two areas are shown in Fig. 6. St. Mary's-Placentia Bays show the continued dominance of the 11+ fish. These bays exhibit a modest increase in age 4-7 groups in 1983, particularly the proportion of autumn spawners.

The Fortune Bay age composition illustrates the relative strength of the 1974 yearclass (except in 1981 when there was poor sampling) and also the predominance of older age groups (11^+ and older) in 1983.

The age composition from the research gillnets (Fig. 7) indicate higher proportions of younger fish from both areas (since mesh sizes ranged from 2-3") but generally indicate similar main features in age distribution as the commercial samples from 1982 and 1983. Interesting to note is the high proportion of fall spawners in the younger age groups (ages 3-7).

2) Age Specific Weights

Table 7 shows the mean weights-at-age derived from all samples collected during the first and second quarters of 1983.

3) Partial Recruitment Rates

Partial recruitment rates (Table 8) were changed from previous assessments to more accurately assess younger age groups and to account for a bait fishery prosecuted entirely by gillnets. Mean lengths at age were calculated from commercial gillnet samples for both areas combined. Selectivity factors per cm length interval were calculated for a 2 5/8" mesh size gillnet (those predominantly used in the commercial fishery) by

averaging selectivity factors for 2½" and 2¾" gillnets as calculated by Olsen (1959). Adjustments were made at younger age groups to account for percent maturity as the fishery in most areas occurred on or near the spawning grounds. The respective selectivity factor per mean length-at-age was then used to initiate cohort analysis.

4) Abundance Indices

Gillnet and ring net purchase slip catch rate as calculated in the past were not available due to closure of the commercial fishery.

The research gillnet program initiated in 1982 was continued for the second year in 1983. In 1983 six southeast coast fishermen (Table 9 and Fig. 1) were contracted to fish a fleet of five gillnets ranging in mesh size from 2" to 3", for a period of 1 month (April to May), to maintain an accurate daily log of catch, and to collect and freeze samples from their catch.

Total catch from the research gillnet program is shown in Table 9. In each of the six locations total catch was greater in 1983 than 1982.

In calculating catch rates, the time variable was examined in two ways: 1) the rate of catch of herring per fishing day (Table 10) which reflects the total amount of time the gear is in the water and 2) the rate of catch of herring per number of days hauled (Table 11). The catch rate using option 1 is always greater than that using option 2.

In all areas (Tables 10-11) using either of the catch rate options, catch rate increased in 1983.

5) 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. As shown in Tables 10-11, there was no trend in calculated Z's for 1982-83 for either of the two options. It was therefore impossible to obtain a best estimate of F_t with which to tune cohort analysis.

However, trial runs of cohort analysis were conducted for each of the stock areas using two options of F_t: 1) $F_t = 0.028$ and 2) $F_t = 0.056$ (Tables 12-15). These values were chosen as they produced weighted average F's of 0.025 and 0.050, respectively. It was felt that $F = 0.025$ reasonably reflected fishing mortality in 1983 and that $F = 0.050$ provided an upper bound to the probable fishing mortality rate in 1983 as the bait fishery in the two stock areas took a total of only 55 t.

Assessment Results

1) Trends in Biomass and F

In both stock areas (Tables 12-15), biomass levels (2^+, 3^+, and 5^+) appear to have ceased their declining trends under either of the options of F_t. In Fortune Bay $B2^+$ increased in 1983 from 1982 under either option whereas $B3^+$ and $B5^+$ decreased in 1983 from 1982. In St. Mary's-Placentia Bays $B2^+$ and $B3^+$ both increased in 1983 from 1982 under either option of F_t whereas $B5^+$ decreased under both options. The results indicate for both stock areas increasing numbers of young fish. Even though the downward trends appears to be waning the total biomass estimates for 1981-83 for both areas under either option of F_t are the lowest for the time series.

Fishing mortality (5^+) estimates were low from both areas (Fig. 8). There has been a steady decline in St. Mary's-Placentia Bays since 1980. In Fortune Bay the $F5^+$ was the same low level in 1982 as 1981 after a steady decline since 1979. These low fishing mortality rates indicate that the low stock levels experienced are attributable mainly to recruitment failure of yearclasses produced during 1970's rather than excessive fishing pressure.

2) Trends in Recruitment

Recruitment of the 1979 yearclass in Fortune Bay at age 2 appears weak, 1.4% the magnitude of the moderate 1974 yearclass and 0.2% of the strong 1968 yearclass. The 1980 yearclass appears stronger but still only 6% the size of the 1974 yearclass and 0.8% of 1968.

The situation is similar in St. Mary's-Placentia Bays. The 1980 yearclass is stronger than 1979 but still only 12.6% of the size of 1974 and 0.8% the size of the 1968 yearclass at age 2.

Winters et al. (1985) point out using a correlation analysis that there is no historical relationship between stock size and recruitment for Fortune Bay herring. Figures 9 and 10, using data from the most recent cohort analyses for Fortune Bay and St. Mary's-Placentia Bays, respectively, illustrate the same. The conclusion is that herring recruitment is largely controlled by environmental factors rather than population fecundity.

Alternative Assessment - Placentia Bay-St. Mary's Bay

The assessment options already presented are illustrative in that a precise estimate of terminal fishing mortality could not be derived. For Placentia Bay-St. Mary's Bay, a catch rate series exists from the commercial gillnet fishery for the period 1977-81 (Moores et al. 1981). In the following analysis (Appendices 1-5), an estimate of instantaneous total mortality for 1977-81 is derived from this catch rate base; a terminal fishing mortality

value is then chosen which gives the same mean fishing mortality rate for 1977-81. To provide a more complete analysis of population dynamics, both spring and autumn-spawning components of the stock are examined since in recent years (Table 5) autumn spawners account for greater than 20% of the stock.

Partial recruitment rates (P.R.) were derived separately for each spawning component. The P.R. for spring spawners was not changed from the previous two options (Table 8). For autumn-spawners, a weighted mean P.R. was calculated using both gillnet and purse seine P.R.'s (Appendix 1). The gillnet P.R.'s were derived, similar to those in Table 8, from empirical selectivity factors of gillnets as calculated by Olsen (1959). The purse seine P.R.'s were estimated from the mean fishing mortality vector of purse seine catches for the period 1973-76. The mean P.R. was weighted by the proportion of the commercial catch taken by each of the two gear types.

Catch rate data were available from purchase slips of the spring (April-June) commercial gillnet fishery for the period 1977-81 (Appendix 2). Mean catch rates were obtained and adjusted to account for annual changes in fleet size (Wheeler and Winters 1983).

Estimates of instantaneous total mortality rates (Paloheimo 1961) were calculated for the period 1977-81 (Appendix 3). This was achieved by applying the catch rates (Appendix 2) to catch-at-age data derived from the commercial gillnet fishery only. A mean $Z_{5+} = 0.43$ was obtained; assuming $M = 0.20$, then $F_{5+} = 0.23$ for the time period 1977-81.

Cohort analyses were performed separately for each spawning component (Appendices 4-5). Terminal fishing mortality values of $F_t = 0.009$ for spring-spawners and $F_t = 0.085$ for autumn-spawners were chosen to given mean $F_{5+} = 0.23$ over the time period 1977-81.

For spring-spawners (Appendix 4), biomass levels showed similar trends to the two previous options (Tables 12 and 13). Present biomass (B_{3+}) estimates were the lowest for the time series and were less than 7% of maximum historical levels. Unlike either of the other two cohort analyses, under this option, biomass (B_{3+}) estimates continued to decrease marginally in 1983 from 1982. Recruitment continued to be poor; the 1980 yearclass, the largest since 1974, was only 24% the size of the 1974 yearclass (at age 2) and only 1.6% the size of the 1968 yearclass. Fishing mortality (5^+) estimates showed the same trends as the previous analyses, declining steadily since 1979.

The analysis for autumn-spawners (Appendix 5) showed a gradual decrease in biomass estimates over the time series; however, estimates (3^+) for 1981 still represented 26% of maximum historical levels. This was due mostly to the recruitment of the 1977 yearclass, which at age 2 was the largest for the time series. Consequently, in 1981, autumn spawners represented 29% of the population (B_{3+}), whereas throughout the 1970's, they represented approximately 8-10% of the (B_{3+}) population.

Discussion

Although there has been poor recruitment to the southeast coast herring stocks since 1974, it appears that the ebb may be near an end. Qualitative estimates from the purse seine fishery indicate that the 1979 yearclass is relatively abundant (by recent standards) in Fortune Bay while the 1982 yearclass is strong in St. Mary's-Placentia Bays. Results from the cohort analysis (Tables 12-15) indicate that 2+ biomass has stabilized in 1983 at about the level of the 1982 biomass level whereas without the input of these younger fish the biomass decreased (3+ and 5+ biomass). These biomass estimates are still extremely low and although there is no direct relationship between spawning stock size and recruitment levels, it is felt that present spawning stock biomass levels may be approaching the critical low levels below which recruitment is directly impaired.

The 1982 yearclass appears to be of sufficient strength in St. Mary's-Placentia Bays to ensure a substantial increase in abundance in this area within the next several years. Although this yearclass has not yet been observed to be abundant in Fortune Bay, the historical parallelism observed in stock size in Newfoundland herring (Winters et al. 1985) suggest that this 1982 yearclass should also be significant in the rebuilding of the Fortune Bay stock. These herring will not however contribute significantly to the spawning stock until 1986 and from a yield-per-recruit viewpoint, will not achieve maximum biomass levels until age 5 in 1987. The production of the 1984 and 1985 yearclasses will therefore depend on environmental factors, egg production of the 1969 and earlier yearclasses which have sustained the stocks in St. Mary's-Placentia Bays in recent years, and the egg production of the 1979 and 1980 yearclasses in Fortune Bay. These fish should be protected within the next two years to ensure that spawning stocks do not reach critical levels below which recruitment could be directly impaired.

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Table 1. St. Mary's Bay - Placentia Bay herring landings (t) by gear, 1973-83.

Year	Area	Gear: Purse seine	Ring net	Bar seine	Gill net	Trap	Total
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.	-	-	-	12	-	12
	P.B.	-	-	-	27	-	27
	Combined	-	-	-	39	-	39

* provisional.

Table 2. Fortune Bay herring landings (t), by gear, 1973-83.

Year	Gear				Total
	Purse seine	Bar seine	Gill net	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[a]	-	-	16	-	16

[a]Provisional.

Table 3. Number of fish sampled from the southeast Newfoundland herring fishery, by area and gear, 1980-83 (research samples in parentheses).

Year	Area	Gear type				Total # sampled	Comm. catch (t)
		Trap	Bar seine	Gill net	Ring net		
1980	G	-	-	-	250	250	1025
	H	-	-	(50)	2189	2189 (50)	1452
	I	-	250	100	200	550	451
	TTL.	-	250	100 (50)	2639	2989 (50)	2928
1981	G	-	-	400 (18)	669	1069 (18)	174
	H	-	-	-	300	300	461
	I	-	-	(34)	-	(34)	67
	TTL.	-	-	400 (52)	969	1369 (52)	702
1982	G	-	-	(315)	-	(315)	10
	H	-	-	(428)	-	(428)	35
	I	-	-	(273)	-	(273)	22
	TTL.	-	-	(1016)	-	(1016)	67
1983	G	-	-	(659)	798	798 (659)	12
	H	100	-	(605)	-	100 (605)	27
	I	-	-	(417)	-	(417)	16
	TTL.	100	-	(1681)	798	898(1681)	55

Table 4. Commercial catch at age for Placentia Bay-St. Mary's Bay spring-spawning herring, 1966-83.

	Year																	
Age	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
2	1.	1.	3232.	1.	476.	1.	1.	77.	996.	74.	365.	52.	30.	88.	133.	1.	1.	1.
3	1066.	1.	439.	629.	109.	557.	207.	326.	281.	2234.	391.	1423.	175.	663.	331.	193.	1.	5.
4	104.	2362.	29.	54.	4434.	116.	20375.	77.	233.	472.	1905.	140.	1817.	279.	133.	42.	2.	2.
5	114.	158.	7417.	53.	59.	2112.	725.	15470.	127.	172.	208.	736.	123.	2264.	153.	111.	3.	3.
6	164.	302.	399.	861.	76.	80.	5154.	593.	14329.	1625.	267.	87.	597.	97.	1269.	51.	8.	2.
7	1912.	788.	679.	67.	645.	44.	366.	6760.	436.	13857.	863.	50.	64.	614.	57.	338.	3.	4.
8	1282.	1451.	953.	55.	67.	252.	100.	95.	6049.	146.	5622.	1039.	106.	86.	470.	28.	14.	1.
9	137.	407.	2836.	99.	72.	13.	900.	33.	138.	3391.	201.	3830.	512.	66.	38.	80.	4.	9.
10	43.	85.	2577.	347.	37.	22.	73.	285.	57.	351.	2256.	134.	3827.	502.	238.	6.	4.	1.
11^{+}	993.	787.	3680.	348.	91.	85.	369.	361.	805.	1321.	136.	2447.	2183.	4784.	2793.	462.	69.	39.
%SS(2^{+})	78	83	88	79	93	85	96	95	94	95	95	91	86	87	81	78	90	59

Table 5. Commercial catch at age for Placentia Bay-St. Mary's Bay autumn-spawning herring, 1969-81.

	Year												
Age	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
2	140.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
3	1.	1.	1.	24.	5.	2.	1.	12.	1.	1.	1.	1.	1.
4	9.	1.	9.	62.	151.	2.	7.	4.	47.	10.	11.	97.	141.
5	1.	2.	2.	176.	52.	96.	69.	214.	53.	229.	143.	35.	119.
6	36.	1.	53.	15.	72.	145.	182.	68.	209.	42.	598.	52.	9.
7	257.	71.	31.	61.	11.	80.	89.	32.	81.	71.	73.	419.	12.
8	100.	113.	43.	37.	55.	96.	205.	17.	70.	20.	217.	79.	51.
9	106.	19.	84.	102.	17.	93.	7.	93.	26.	7.	20.	126.	7.
10	78.	28.	35.	71.	63.	51.	37.	11.	22.	11.	2.	26.	1.
11^{+}	816.	201.	317.	529.	739.	799.	678.	329.	490.	91.	332.	471.	38.
%AS(2^{+})	29	7	15	4	5	6	5	5	9	14	13	19	20

Table 6. Commercial catch at age for Fortune Bay spring-spawning herring, 1966-83.

Age	Year																	
	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
2	1.	1.	6549.	515.	42383.	174.	1536.	2220.	389.	2.	82.	28.	1.	1.	25.	1.	1.	1.
3	223.	89.	128.	11984.	7997.	24094.	260.	924.	1333.	279.	15.	2114.	42.	1.	16.	144.	1.	3.
4	13.	24764.	317.	85.	10433.	6314.	19975.	67.	543.	582.	318.	25.	2705.	183.	3.	16.	3.	2.
5	22.	46.	48563.	187.	87.	24357.	2941.	5671.	121.	112.	228.	328.	63.	3811.	69.	4.	3.	1.
6	90.	49.	216.	13038.	189.	1210.	10937.	454.	4574.	87.	129.	166.	240.	15.	1122.	3.	1.	1.
7	66.	422.	124.	188.	7312.	270.	357.	1749.	117.	1490.	11.	26.	44.	165.	7.	21.	2.	1.
8	90.	450.	610.	261.	241.	9314.	4458.	78.	1119.	16.	337.	44.	141.	5.	183.	2.	36.	1.
9	28.	513.	770.	690.	16.	137.	1054.	240.	9.	142.	36.	189.	52.	24.	1.	23.	1.	11.
10	2.	358.	920.	1935.	234.	153.	35.	598.	117.	22.	187.	4.	330.	1.	11.	1.	5.	1.
11^{+}	17.	15.	617.	884.	141.	261.	80.	15.	199.	63.	14.	140.	5.	87.	1.	2.	1.	10.
%SS(2+)	85	97	94	95	97	95	97	97	97	94	92	98	98	98	99	72	84	91

Table 7. Mean weight at age (g) of southeast coast Newfoundland herring from samples collected in 1st and 2nd quarters, 1983.

	Area	
Age	G & H	I
2	99	70
3	164	164
4	237	238
5	280	264
6	312	316
7	349	363
8	375	360
9	378	400
10	395	412
11+	431	426

Table 8. Age specific selectivity pattern used in 1983 for east and southeast Newfoundland spring spawning herring, as derived from Olsen (1959),

Age	Selectivity Factor
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	0.77
12	0.71
13	0.66
14	0.60
15	0.54
16	0.48
17	0.43
18	0.40
19	0.36
20	0.36

Table 9. Total catch (number of fish), number of days hauled, and number of days fished for research gillnet program.

Area	Community	1982 Total catch	1982 Days hauled	1982 Days fished	1983 Total catch	1983 Days hauled	1983 Days fished
G & H	Riverhead	680	19	(25)	962	24	(31)
	Colinet	71	26	(31)	3193	30	(36)
	Long Harbour	662	19	(32)	3142	18	(29)
	Swift Current	481	20	(31)	1870	22	(30)
I	Belle Bay area	746	25	(32)	1161	9	(20)
	Long Harbour area	48	25	(31)	9711	23	(29)

Table 10. CPUE indices (total number of herring caught per fishing day) from research gillnet program and calculation of instantaneous total mortality, Z.

Area	Community	Catch rates		F (fishing days)		Z3+
		1982	1983	1982	1983	Z82-83
G & H	Riverhead	27	31	25	31	0.09
	Colinet	2	89	31	36	-3.44
	Long Harbour	21	108	32	29	-1.27
	Swift Current	16	62	31	30	-1.16
	Average	22	73	119	126	-1.24
I	Long Harbour	23	58	32	20	-5.56
	Belle Bay	2	335	31	29	-0.42
	Average	13	222	63	49	-2.79

Table 11. CPUE indices (total number of herring per days nets hauled) from research gillnet program and calculation of instantaneous total mortality, Z.

Area	Community	Catch rates		F (days hauled)		Z3+
		1982	1983	1982	1983	Z82-83
G & H	Riverhead	36	40	19	24	0.11
	Colinet	3	106	26	30	-3.45
	Long Harbour	35	175	19	18	-1.23
	Swift Current	24	85	20	22	-1.03
	Average	23	98	84	94	-1.18
I	Long Harbour	30	129	25	9	-6.11
	Belle Bay	2	422	25	23	-0.43
	Average	16	340	50	32	-2.99

Table 12. Results of cohort analysis for Placentia Bay-St. Mary's Bay using F_t = 0.028.

Herring Area G&H-Fishing Mortalities

	Year																	
Age	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
2	.000	.000	.024	.000	.002	.000	.000	.029	.077	.045	.026	.044	.018	.130	.255	.004	.001	.000
3	.022	.000	.039	.006	.015	.003	.014	.078	.139	.249	.353	.132	.203	.690	1.017	.723	.005	.003
4	.017	.061	.006	.006	.052	.019	.141	.006	.073	.365	.349	.205	.248	.577	.279	.320	.014	.012
5	.019	.032	.274	.014	.008	.031	.161	.151	.013	.071	.271	.219	.279	.558	.739	.397	.033	.025
6	.019	.064	.106	.046	.025	.014	.100	.192	.204	.225	.150	.173	.278	.372	.717	.590	.044	.028
7	.136	.120	.202	.023	.044	.018	.079	.185	.210	.311	.179	.038	.186	.516	.390	.417	.059	.028
8	.134	.146	.208	.022	.029	.022	.053	.027	.251	.101	.200	.340	.105	.409	.998	.338	.027	.025
9	.051	.057	.469	.030	.037	.007	.100	.022	.049	.218	.196	.203	.280	.088	.319	.441	.073	.021
10	.020	.041	.606	.094	.014	.014	.049	.042	.048	.169	.220	.194	.322	.489	.518	.075	.034	.023
11	.110	.019	.240	.058	.013	.011	.062	.052	.076	.112	.203	.227	.249	.460	.522	.138	.016	.022
12	.025	.115	.105	.019	.011	.011	.049	.066	.076	.155	.107	.206	.306	.322	.473	.139	.025	.020
13	.027	.032	.984	.008	.003	.010	.046	.051	.098	.160	.188	.074	.269	.428	.284	.120	.027	.018
14	.031	.035	.040	.121	.001	.003	.041	.048	.074	.214	.190	.194	.073	.359	.423	.060	.023	.017
15	.031	.039	.044	.051	.024	.001	.012	.042	.071	.157	.270	.190	.254	.108	.325	.105	.011	.015
16	.031	.039	.050	.056	.067	.020	.005	.013	.061	.148	.184	.291	.243	.316	.087	.078	.019	.013
17	.052	.039	.050	.065	.073	.088	.090	.004	.019	.126	.171	.185	.439	.308	.270	.070	.018	.012
18	.247	.068	.050	.065	.085	.098	.119	.099	.005	.037	.144	.167	.231	.774	.264	.062	.016	.011
19	.249	.420	.089	.065	.086	.115	.134	.168	.153	.010	.038	.137	.209	.291	1.384	.038	.004	.010
20	.249	.420	.984	.121	.086	.115	.161	.192	.251	.365	.353	.340	.439	.774	1.384	.723	.073	.010
F_{2+}	.051	.062	.109	.015	.017	.010	.115	.134	.168	.251	.178	.190	.266	.452	.510	.205	.016	
F_{3+}	.054	.072	.267	.016	.042	.011	.118	.135	.178	.255	.215	.194	.278	.463	.523	.214	.023	
F_{5+}	.089	.091	.335	.045	.027	.026	.095	.146	.181	.254	.198	.211	.290	.449	.519	.188	.024	

Table 12 (Cont'd.)

Herring Area G&H-Populations Numbers

	Year																	
Age	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
2	7599.	15415.	148901.	10166.	256849.	20464.	5885.	3007.	14783.	1856.	15979.	1343.	1829.	797.	653.	284.	2010.	3941.
3	55326.	6221.	12620.	118986.	8322.	209859.	16753.	4818.	2392.	11202.	1453.	12752.	1053.	1470.	573.	414.	232.	1645.
4	6886.	44332.	5092.	9935.	96848.	6715.	171314.	13529.	3649.	1704.	7150.	836.	9153.	704.	604.	170.	165.	189.
5	6665.	5544.	34159.	4143.	8085.	75281.	5393.	121824.	11007.	2777.	968.	4130.	558.	5850.	324.	374.	101.	133.
6	9602.	5354.	4396.	21256.	3344.	6566.	59723.	3759.	85743.	8897.	2118.	605.	2716.	345.	2741.	127.	206.	80.
7	16566.	7713.	4110.	3238.	16624.	2669.	5304.	44234.	2541.	57235.	5814.	1492.	416.	1683.	195.	1096.	57.	161.
8	11318.	11833.	5602.	2751.	2591.	13027.	2145.	4011.	30099.	1686.	34322.	3979.	1177.	283.	822.	108.	591.	44.
9	3037.	8106.	8375.	3724.	2202.	2060.	10437.	1666.	3198.	19170.	1248.	23013.	2318.	867.	154.	248.	63.	471.
10	2383.	2362.	6269.	4291.	2960.	1738.	1675.	7731.	1334.	2493.	12626.	840.	15376.	1434.	651.	92.	131.	48.
11	10492.	1912.	1857.	2801.	3199.	2390.	1403.	1305.	6072.	1041.	1724.	8296.	567.	9126.	720.	317.	70.	103.
12	44.	7692.	1536.	1196.	2164.	2585.	1935.	1080.	1015.	4609.	762.	1153.	5412.	362.	4716.	350.	226.	56.
13	41.	35.	5615.	1132.	961.	1751.	2094.	1509.	828.	770.	3231.	560.	768.	3263.	215.	2405.	249.	181.
14	36.	33.	28.	1718.	919.	784.	1420.	1636.	1174.	615.	537.	2193.	426.	481.	1741.	132.	1746.	199.
15	36.	29.	26.	22.	1247.	752.	640.	1116.	1276.	892.	406.	364.	1479.	324.	275.	934.	102.	1397.
16	36.	29.	23.	20.	17.	996.	615.	518.	876.	973.	625.	254.	246.	939.	238.	163.	689.	83.
17	22.	29.	23.	18.	16.	13.	799.	500.	418.	674.	688.	426.	155.	158.	561.	179.	123.	553.
18	5.	17.	22.	18.	14.	12.	10.	598.	408.	336.	487.	474.	290.	82.	95.	351.	137.	99.
19	5.	3.	13.	17.	13.	10.	9.	7.	444.	332.	265.	345.	329.	188.	31.	60.	270.	110.
20	5.	3.	2.	10.	13.	10.	7.	6.	5.	312.	269.	209.	247.	218.	115.	6.	47.	220.
B_{2+}	28990	26050	35466	33401	46906	58043	61232	50880	40528	31534	22732	17921	13977	9782	5845	2891	2262	2330
B_{3+}	28420	24894	24001	32577	33807	56487	60785	50631	39479	31374	21566	17815	13830	9703	5776	2868	2063	1940
B_{5+}	18647	16247	21079	13347	13283	27231	25655	47046	38321	29302	19642	15648	11470	9306	5530	2761	1986	1625

Table 13. Results of cohort analysis for Placentia Bay-St. Mary's Bay using F_t = 0.056.

Herring Area G&H-Fishing Mortalities

	Year																	
Age	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
2	.000	.000	.025	.000	.002	.000	.000	.031	.079	.048	.027	.046	.021	.147	.322	.008	.001	.001
3	.023	.000	.043	.006	.016	.003	.015	.091	.150	.256	.383	.141	.217	.846	1.309	1.121	.009	.007
4	.018	.065	.008	.007	.054	.021	.147	.007	.086	.405	.361	.229	.269	.636	.386	.543	.027	.024
5	.019	.035	.296	.018	.009	.033	.174	.158	.014	.085	.313	.230	.323	.634	.906	.654	.065	.050
6	.019	.065	.116	.050	.033	.015	.105	.210	.216	.240	.184	.208	.296	.457	.930	.917	.085	.056
7	.138	.121	.203	.025	.048	.024	.087	.195	.236	.335	.194	.047	.233	.566	.537	.692	.114	.055
8	.134	.147	.212	.022	.032	.024	.069	.029	.268	.115	.220	.377	.134	.562	1.246	.556	.052	.050
9	.054	.057	.476	.030	.037	.008	.111	.029	.054	.236	.230	.229	.323	.116	.522	.723	.139	.043
10	.021	.043	.610	.095	.014	.014	.055	.047	.065	.189	.244	.236	.376	.610	.776	.142	.067	.046
11	.112	.020	.257	.059	.013	.011	.062	.058	.085	.155	.232	.259	.321	.587	.780	.252	.031	.043
12	.026	.117	.112	.020	.011	.011	.050	.066	.085	.178	.155	.244	.365	.459	.724	.253	.048	.040
13	.029	.033	1.016	.008	.004	.010	.047	.052	.099	.183	.221	.111	.337	.560	.477	.222	.053	.037
14	.033	.037	.042	.127	.001	.003	.042	.050	.076	.216	.223	.238	.114	.495	.662	.115	.045	.034
15	.033	.041	.046	.053	.026	.002	.013	.043	.073	.160	.273	.232	.330	.179	.531	.195	.022	.030
16	.033	.041	.053	.060	.069	.021	.006	.014	.062	.152	.189	.295	.312	.455	.155	.147	.038	.027
17	.054	.042	.053	.069	.078	.092	.095	.005	.020	.127	.177	.191	.449	.437	.457	.133	.036	.024
18	.250	.071	.053	.069	.091	.105	.125	.106	.006	.040	.146	.173	.241	.808	.434	.119	.032	.022
19	.252	.426	.094	.069	.091	.123	.145	.177	.166	.011	.042	.139	.219	.308	1.598	.069	.008	.020
20	.252	.426	1.016	.127	.091	.123	.174	.210	.268	.405	.383	.337	.449	.836	1.598	1.121	.139	.020
F_{2+}	.053	.066	.114	.016	.017	.011	.121	.141	.179	.271	.196	.212	.306	.559	.739	.366	.033	
F_{3+}	.056	.076	.286	.017	.045	.012	.123	.143	.190	.275	.237	.216	.321	.574	.763	.379	.045	
F_{5+}	.090	.093	.353	.048	.029	.028	.101	.155	.193	.276	.220	.238	.341	.559	.763	.336	.047	

Table 13 (Cont'd.)

Herring Area G+H-Population Numbers

	Year																	
Age	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
2	5959.	14207.	143380.	9491.	247516.	19378.	5077.	2802.	24473.	1739.	15033.	1271.	1613.	709.	533.	144.	1007.	1971.
3	52046.	4878.	11631.	114465.	7770.	202218.	15864.	4156.	2225.	10949.	1357.	11978.	993.	1293.	501.	316.	117.	824.
4	6354.	41647.	3993.	9125.	93147.	6263.	165058.	12801.	3108.	1567.	6942.	757.	8519.	655.	459.	111.	84.	95.
5	6634.	5108.	31960.	3243.	7422.	72250.	5022.	116702.	10411.	2333.	856.	3960.	493.	5331.	284.	255.	53.	67.
6	9482.	5328.	4039.	19456.	2607.	6023.	57242.	3456.	81550.	8409.	1755.	513.	2576.	292.	2316.	94.	109.	40.
7	16420.	7615.	4089.	2946.	15150.	2066.	4859.	42203.	2293.	53802.	5414.	1195.	341.	1569.	152.	748.	31.	82.
8	11269.	11713.	5522.	2734.	2351.	11820.	1651.	3647.	28436.	1483.	31511.	3652.	933.	221.	729.	73.	306.	22.
9	2881.	8066.	8277.	3658.	2188.	1864.	9450.	1262.	2900.	17808.	1082.	20712.	2050.	668.	103.	172.	34.	238.
10	2250.	2234.	6236.	4211.	2906.	1727.	1515.	6922.	1003.	2250.	11512.	704.	13492.	1215.	487.	50.	68.	24.
11	10339.	1804.	1752.	2774.	3133.	2345.	1394.	1174.	5410.	770.	1524.	7384.	455.	7583.	541.	184.	36.	52.
12	43.	7567.	1447.	1110.	2141.	2531.	1899.	1072.	907.	4067.	540.	989.	4664.	270.	3453.	203.	117.	28.
13	39.	34.	5513.	1059.	891.	1733.	2050.	1479.	822.	682.	2787.	378.	634.	2651.	140.	1371.	129.	91.
14	34.	31.	27.	1634.	860.	727.	1406.	1600.	1150.	609.	465.	1829.	277.	371.	1240.	71.	899.	100.
15	34.	27.	24.	21.	1178.	703.	593.	1104.	1247.	872.	402.	305.	1181.	203.	185.	524.	52.	703.
16	34.	27.	21.	19.	17.	940.	575.	479.	866.	949.	608.	251.	198.	695.	139.	89.	353.	42.
17	21.	27.	21.	17.	15.	13.	753.	468.	387.	666.	668.	412.	153.	119.	361.	97.	63.	278.
18	5.	16.	21.	17.	13.	11.	9.	561.	381.	310.	480.	458.	279.	80.	63.	187.	70.	50.
19	5.	3.	12.	17.	13.	10.	8.	7.	413.	310.	244.	340.	315.	179.	29.	33.	136.	55.
20	5.	3.	2.	9.	13.	9.	7.	6.	5.	286.	251.	192.	242.	207.	108.	5.	25.	111.
B_{2+}	28003.	24960.	33855.	31603.	44629.	55378.	58410.	48249.	38155.	29381.	20804.	16123.	12304.	8257.	4425.	1730.	1163.	1172.
B_{3+}	27556.	23895.	22814.	30834.	32006.	53906.	58024.	48016.	37127.	29232.	19707.	16023.	12175.	8187.	4369.	1718.	1063.	977.
B_{5+}	18388.	15917.	20260.	12426.	12304.	25750.	24220.	44689.	36111.	27228.	17847.	13995.	9976.	7830.	4170.	1641.	1024.	819.

Table 14. Results of cohort analysis for Fortune Bay, using $F_t = 0.028$.

Herring Area I-Fishing Mortalities

	Year																	
Age	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
2	.000	.000	.055	.018	.386	.044	.317	.426	.063	.004	.004	.046	.009	.008	.094	.004	.001	.000
3	.001	.004	.017	.136	.417	.397	.085	.320	.493	.059	.042	.152	.090	.011	.164	1.184	.005	.003
4	.006	.174	.018	.014	.169	.692	.679	.028	.315	.416	.088	.091	.296	.697	.040	.245	.059	.012
5	.012	.025	.607	.014	.018	.741	.839	.411	.066	.098	.283	.124	.345	.896	.624	.069	.066	.025
6	.018	.033	.154	.320	.017	.365	.923	.285	.695	.061	.157	.344	.125	.128	.737	.047	.022	.028
7	.010	.110	.111	.194	.299	.030	.173	.351	.109	.509	.010	.043	.143	.119	.081	.025	.040	.028
8	.021	.087	.230	.358	.409	.780	.966	.052	.399	.020	.203	.049	.340	.021	.187	.030	.055	.025
9	.010	.160	.210	.443	.033	.432	.178	.113	.007	.079	.056	.167	.076	.088	.005	.032	.019	.021
10	.012	.166	.478	1.260	.263	.493	.185	.145	.074	.023	.142	.008	.491	.002	.053	.007	.009	.023
11	.017	.121	.477	1.270	.255	.526	.522	.112	.066	.052	.018	.150	.012	.228	.002	.012	.008	.022
12	.037	.166	.318	1.267	.257	.501	.587	.440	.050	.046	.042	.016	.279	.003	.098	.003	.007	.020
13	.045	.047	.477	.579	.256	.505	.537	.532	.246	.038	.036	.040	.024	.108	.004	.025	.003	.018
14	.066	.058	.061	1.268	.080	.507	.542	.463	.330	.206	.032	.034	.064	.007	.041	.004	.012	.017
15	.082	.086	.075	.079	.260	.107	.544	.478	.283	.290	.206	.020	.053	.022	.003	.012	.005	.015
16	.087	.110	.117	.101	.106	.530	.071	.492	.266	.223	.283	.235	.025	.018	.008	.004	.005	.013
17	.176	.118	.153	.164	.139	.147	.602	.095	.332	.253	.227	.309	.564	.031	.007	.003	.005	.012
18	.202	.268	.166	.226	.246	.200	.215	.595	.129	.275	.267	.266	.805	.263	.040	.002	.004	.011
19	.203	.320	.471	.248	.371	.416	.316	.347	.285	.185	.215	.207	.686	.360	.458	.051	.002	.010
20	.203	.320	.607	1.270	.417	.780	.966	.595	.695	.509	.283	.344	.805	.896	.737	1.184	.066	.010
F_{2+}	.002	.140	.249	.166	.295	.500	.630	.311	.294	.151	.046	.127	.227	.422	.235	.049	.013	
F_{3+}	.003	.147	.445	.194	.215	.514	.655	.294	.357	.154	.100	.129	.229	.427	.242	.051	.017	
F_{5+}	.015	.106	.561	.295	.191	.609	.692	.313	.341	.161	.106	.099	.156	.424	.245	.016	.017	

Table 14 (Cont'd.)

Herring Area I-Population Numbers

	Year																	
Age	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
2	28712.	10231.	134299.	32203.	146181.	4489.	6255.	7075.	7008.	498.	20370.	689.	128.	144.	308.	284.	1206.	3941.
3	209665.	23507.	8376.	104029.	25899.	81333.	3517.	3731.	3784.	5385.	406.	16603.	539.	104.	117.	229.	232.	987.
4	2577.	171457.	19165.	6742.	74328.	13969.	44789.	2645.	2219.	1892.	4157.	319.	11681.	403.	84.	81.	57.	189.
5	2041.	2098.	117970.	15404.	5443.	51414.	5723.	18596.	2105.	1325.	1022.	3115.	238.	7116.	164.	66.	52.	44.
6	5557.	1651.	1676.	52644.	12443.	4377.	20055.	2025.	10094.	1614.	984.	631.	2254.	138.	2378.	72.	50.	40.
7	7389.	4468.	1308.	1177.	31304.	10016.	2489.	6524.	1247.	4125.	1242.	689.	366.	1628.	100.	931.	56.	40.
8	4784.	5990.	3276.	959.	794.	19013.	7956.	1715.	3759.	915.	2029.	1007.	540.	260.	1184.	75.	744.	44.
9	3194.	3836.	4497.	2130.	549.	432.	7139.	2480.	1333.	2065.	735.	1357.	785.	315.	208.	804.	60.	576.
10	180.	2590.	2676.	2985.	1120.	435.	229.	4891.	1814.	1084.	1562.	569.	940.	596.	236.	170.	637.	48.
11	1106.	145.	1796.	1359.	693.	705.	217.	156.	3464.	1379.	867.	1110.	462.	471.	487.	183.	138.	517.
12	31.	890.	105.	912.	312.	440.	341.	106.	114.	2656.	1072.	697.	782.	374.	307.	398.	148.	112.
13	25.	24.	618.	63.	210.	198.	218.	155.	56.	89.	2077.	841.	562.	485.	305.	228.	325.	120.
14	17.	20.	19.	314.	29.	133.	98.	104.	75.	36.	70.	1640.	662.	449.	356.	249.	182.	265.
15	14.	13.	15.	14.	72.	22.	66.	47.	54.	44.	24.	56.	1298.	508.	365.	280.	203.	147.
16	13.	11.	10.	12.	11.	46.	16.	31.	24.	33.	27.	16.	45.	1007.	407.	298.	226.	165.
17	7.	10.	8.	7.	9.	8.	22.	12.	16.	15.	22.	17.	10.	36.	810.	331.	243.	184.
18	6.	5.	7.	5.	5.	6.	6.	10.	9.	9.	9.	14.	10.	5.	28.	659.	270.	198.
19	6.	4.	3.	5.	4.	3.	4.	4.	4.	7.	6.	6.	9.	4.	3.	22.	538.	220.
20	6.	4.	2.	2.	3.	2.	2.	2.	2.	3.	4.	4.	4.	4.	2.	2.	17.	440.
B_{2+}	39038.	46326.	48306.	39772.	44947.	38353.	23427.	12035.	9008.	6284.	6366.	6267.	5571.	4071.	2532.	1789.	1716.	1797.
B_{3+}	37028.	45610.	38905.	37517.	34715.	38039.	22989.	11540.	8518.	6249.	4940.	6219.	5562.	4061.	2511.	1769.	1632.	1521.
B_{5+}	7564.	7046.	33801.	21773.	15829.	23937.	13278.	10480	7538.	5117.	4027.	3862.	3082.	3964.	2477.	1721.	1580.	1314.

Table 15. Results of coohort analysis for Fortune Bay, using F_t = 0.056.

Herring Area I-Fishing Mortalities

	Year																	
Age	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
2	.000	.000	.056	.019	.389	.065	.352	.459	.082	.006	.005	.052	.015	.011	.109	.008	.002	.001
3	.001	.005	.022	.138	.441	.401	.131	.372	.557	.078	.055	.162	.102	.019	.246	1.657	.009	.007
4	.006	.180	.021	.019	.172	.764	.694	.045	.390	.507	.120	.122	.320	.846	.072	.416	.114	.024
5	.012	.027	.640	.015	.024	.764	1.057	.426	.108	.128	.380	.174	.512	1.049	.948	.130	.126	.050
6	.018	.033	.168	.348	.019	.521	.991	.427	.742	.105	.213	.529	.187	.216	1.101	.088	.043	.056
7	.010	.110	.111	.216	.335	.034	.283	.401	.189	.575	.017	.060	.256	.189	.148	.047	.078	.055
8	.021	.087	.231	.359	.474	.968	1.228	.091	.488	.035	.242	.089	.531	.041	.331	.057	.106	.050
9	.010	.160	.210	.444	.033	.547	.256	.173	.014	.102	.104	.208	.144	.158	.010	.02	.037	.043
10	.013	.166	.478	1.262	.264	.495	.258	.225	.119	.042	.191	.015	.677	.004	.100	.013	.017	.046
11	.017	.127	.480	1.273	.255	.529	.526	.167	.108	.087	.034	.213	.023	.374	.004	.024	.016	.043
12	.037	.166	.336	1.282	.258	.504	.592	.446	.077	.078	.073	.030	.441	.006	.181	.005	.015	.040
13	.046	.048	.478	.634	.262	.509	.541	.541	.251	.060	.064	.072	.046	.195	.007	.048	.007	.037
14	.069	.059	.062	1.274	.090	.526	.549	.469	.338	.211	.052	.062	.119	.015	.079	.009	.024	.034
15	.086	.091	.077	.081	.263	.123	.580	.488	.289	.300	.212	.033	.101	.043	.006	.023	.011	.030
16	.092	.117	.123	.103	.108	.539	.083	.549	.274	.229	.296	.244	.042	.035	.016	.007	.010	.027
17	.177	.125	.164	.175	.141	.151	.619	.112	.392	.263	.235	.329	.597	.054	.014	.007	.009	.024
18	.207	.269	.178	.246	.266	.205	.222	.626	.156	.347	.281	.277	.902	.287	.070	.003	.008	.022
19	.209	.330	.473	.272	.416	.465	.326	.361	.309	.232	.293	.221	.734	.443	.520	.093	.004	.020
20	.209	.330	.640	1.282	.474	.968	1.228	.626	.742	.575	.380	.529	.902	1.049	1.101	1.657	.126	.020
F_{2+}	.002	.147	.260	.175	.306	.533	.709	.371	.380	.209	.055	.155	.291	.610	.401	.093	.026	
F_{3+}	.003	.153	.478	.204	.228	.544	.738	.355	.460	.214	.146	.158	.293	.617	.421	.098	.033	
F_{5+}	.015	.107	.588	.321	.218	.670	.844	.373	.450	.231	.160	.152	.258	.615	.429	.032	.033	

Table 15 (Cont'd.)

Herring Area I-Population Numbers

Age	Year																	
	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
2	25433.	7815.	132458.	30853.	145199.	3041.	5716.	6665.	5460.	381.	19214.	616.	73.	100.	268.	144.	605.	1917.
3	203105.	20822.	6397.	102522.	24794.	80529.	2332.	3290.	3448.	4118.	310.	15657.	479.	59.	81.	197.	117.	494.
4	2381.	166087.	16967.	5122.	73094.	13064.	44130.	1674.	1858.	1617.	3119.	240.	10906.	354.	48.	52.	31.	95.
5	2037.	1937.	113573.	13604.	4116.	50404.	4983.	18057.	1310.	1030.	797.	2266.	174.	6481.	124.	36.	28.	22.
6	5549.	1648.	1545.	49044.	10969.	3291.	19228.	1418.	9652.	963.	742.	446.	1558.	85.	1858.	39.	26.	20.
7	7385.	4462.	1305.	1069.	28356.	8810.	1600.	5847.	750.	3764.	710.	490.	215.	1059.	56.	506.	30.	20.
8	4781.	5986.	3271.	956.	705.	16600.	6968.	987.	3204.	508.	1733.	571.	378.	136.	718.	40.	395.	22.
9	3184.	3833.	4494.	2126.	547.	359.	5163.	1672.	737.	1611.	402.	1114.	428.	182.	107.	422.	31.	291.
10	173.	2582.	2674.	2983.	1116.	433.	170.	3274.	1151.	196.	1190.	296.	741.	303.	127.	87.	325.	24.
11	1105.	139.	1790.	1357.	691.	702.	216.	108.	2139.	837.	468.	805.	239.	308.	247.	94.	70.	261.
12	30.	889.	101.	907.	311.	438.	339.	104.	75.	1571.	628.	370.	533.	191.	174.	202.	75.	57.
13	25.	24.	617.	59.	206.	197.	217.	153.	55.	57.	1190.	478.	294.	281.	156.	119.	164.	61.
14	17.	19.	18.	313.	26.	130.	97.	103.	73.	35.	44.	913.	364.	230.	189.	127.	93.	133.
15	13.	13.	15.	14.	72.	19.	63.	46.	53.	43.	23.	34.	703.	265.	186.	143.	103.	74.
16	13.	10.	10.	11.	11.	45.	14.	29.	23.	32.	26.	15.	27.	520.	208.	151.	114.	83.
17	7.	9.	7.	7.	8.	8.	22.	10.	14.	14.	21.	16.	10.	21.	411.	167.	123.	93.
18	6.	5.	7.	7.	8.	8.	22.	10.	14.	14.	9.	14.	9.	4.	16.	331.	136.	100.
19	6.	4.	3.	5.	3.	3.	4.	4.	4.	5.	4.	6.	8.	3.	3.	12.	271.	111.
20	6.	4.	2.	1.	3.	2.	2.	2.	2.	2.	3.	3.	4.	3.	2.	1.	9.	221.
B_{2+}	37849.	44630.	46349.	37668.	42769.	36199.	21370.	10111.	7148.	4564.	4737.	4790.	4252.	2926.	1544.	940.	877.	904.
B_{3+}	36069.	44083.	37077.	35508.	32632.	35986.	20970.	9644.	6766.	4537.	3392.	4747.	4247.	2919.	1525.	930.	835.	766.
B_{5+}	7550.	6995.	32699.	20305.	14153.	22182.	11557.	8845.	5907.	3636.	2706.	2537.	1934.	2837.	1504.	892.	808.	663.

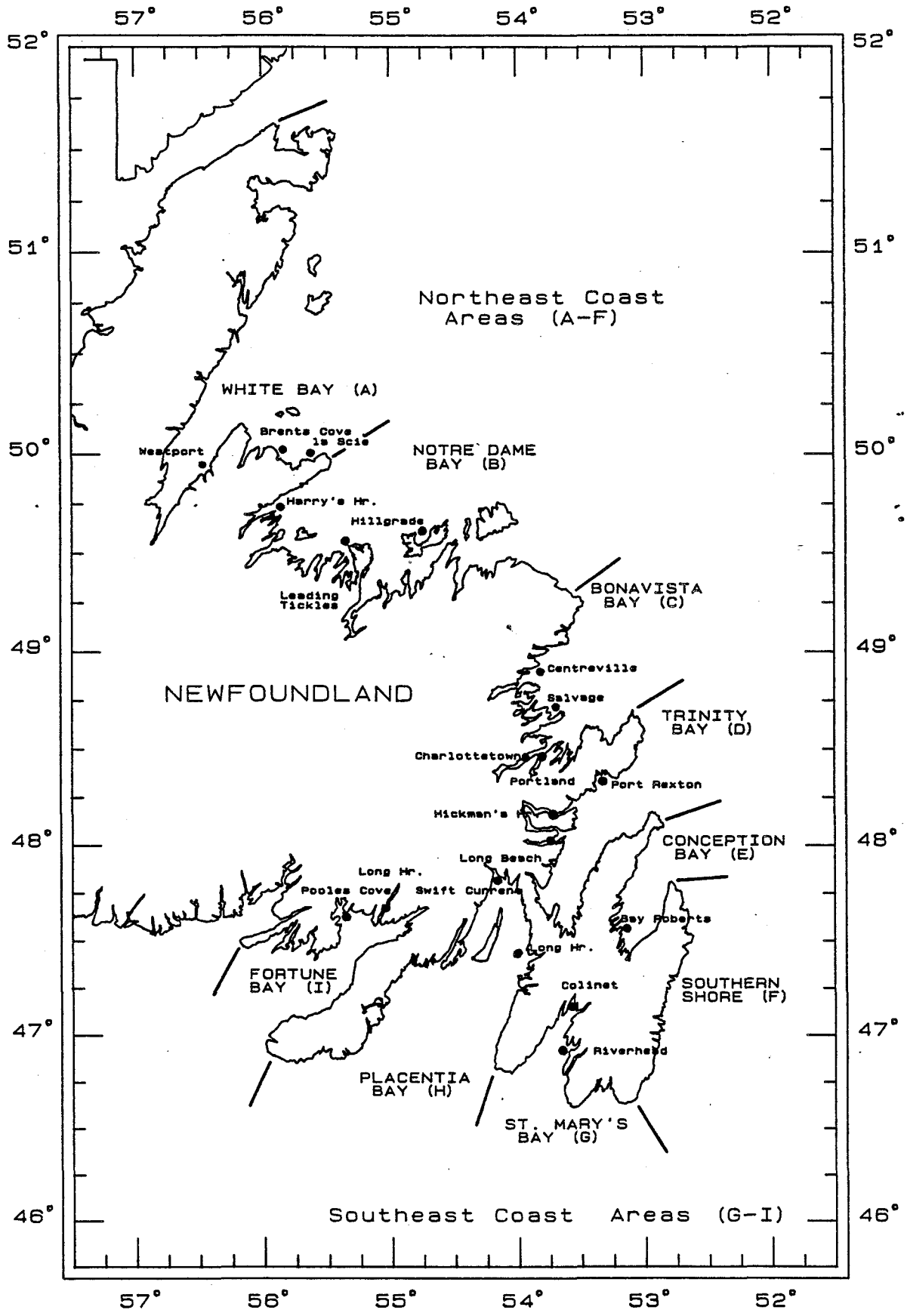

Fig.1. Area map indicating stock areas and research gillnet community locations.

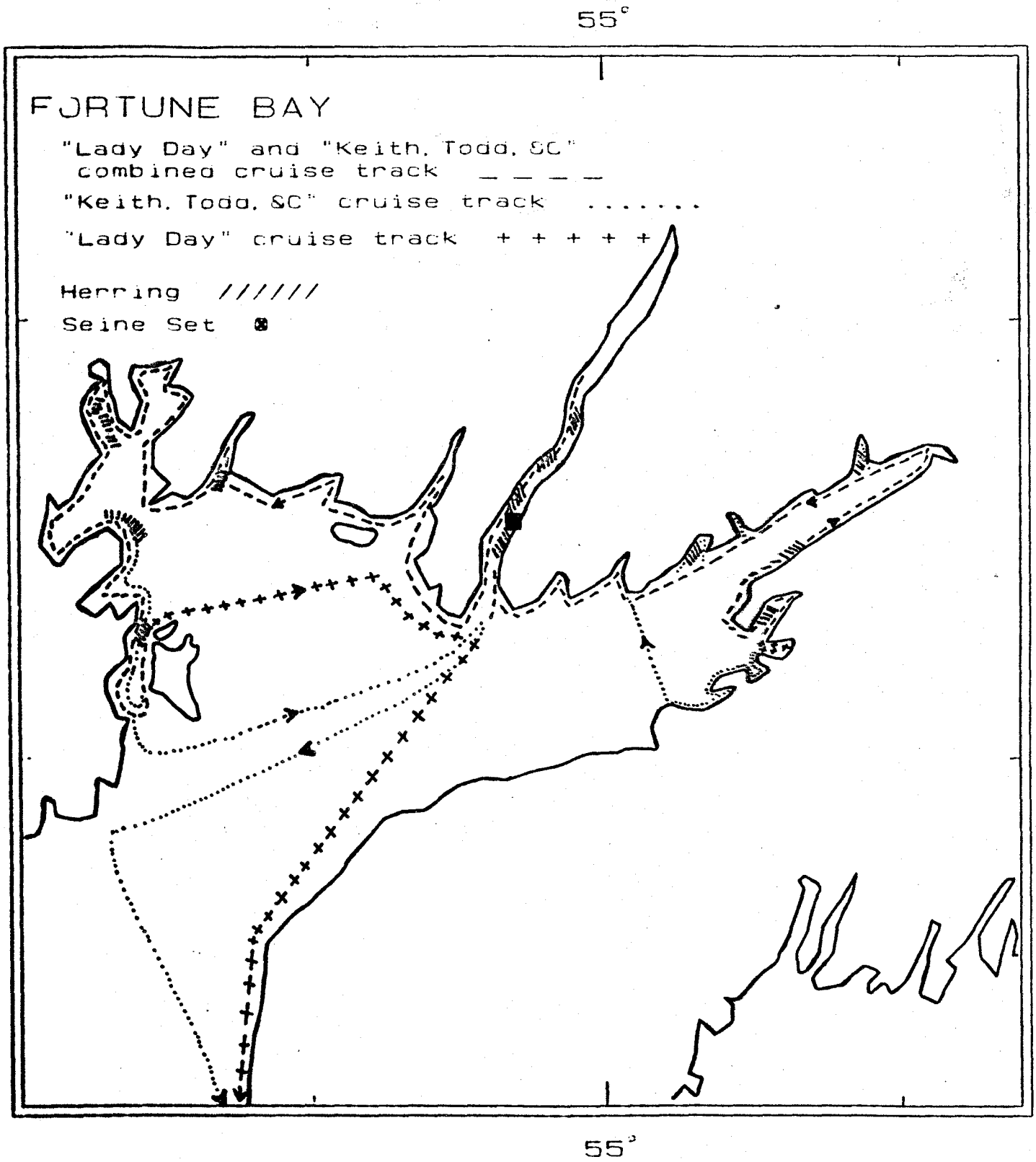

Fig.2 "Lady Day" and "Keith, Todd, &C" cruise tracks, herring markings, and set locations, Fortune Bay.

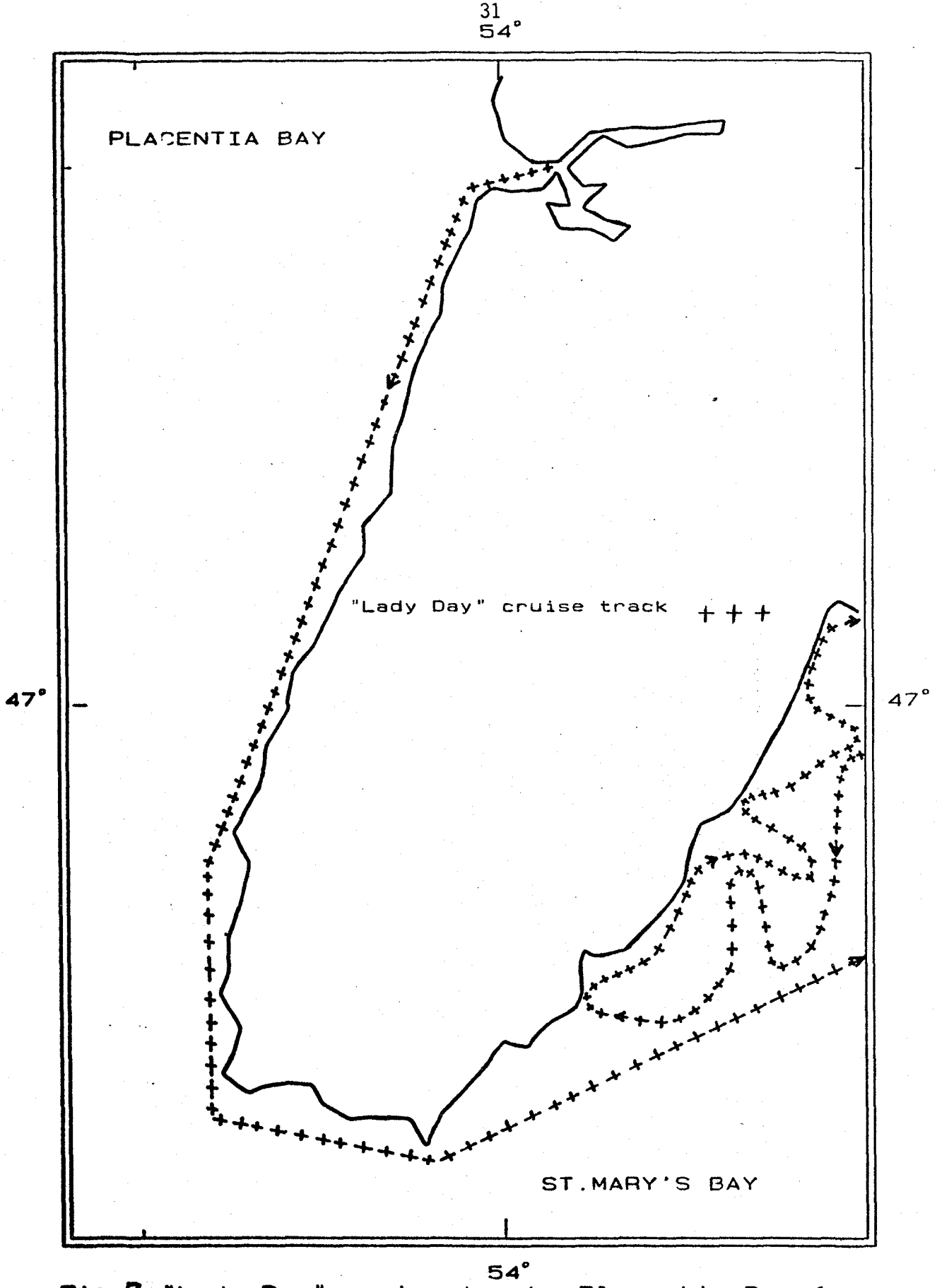

Fig.3 "Lady Day" cruise track. Placentia Bay from Argentia to Cape St.Mary's, and west side of St.Mary's Bay.

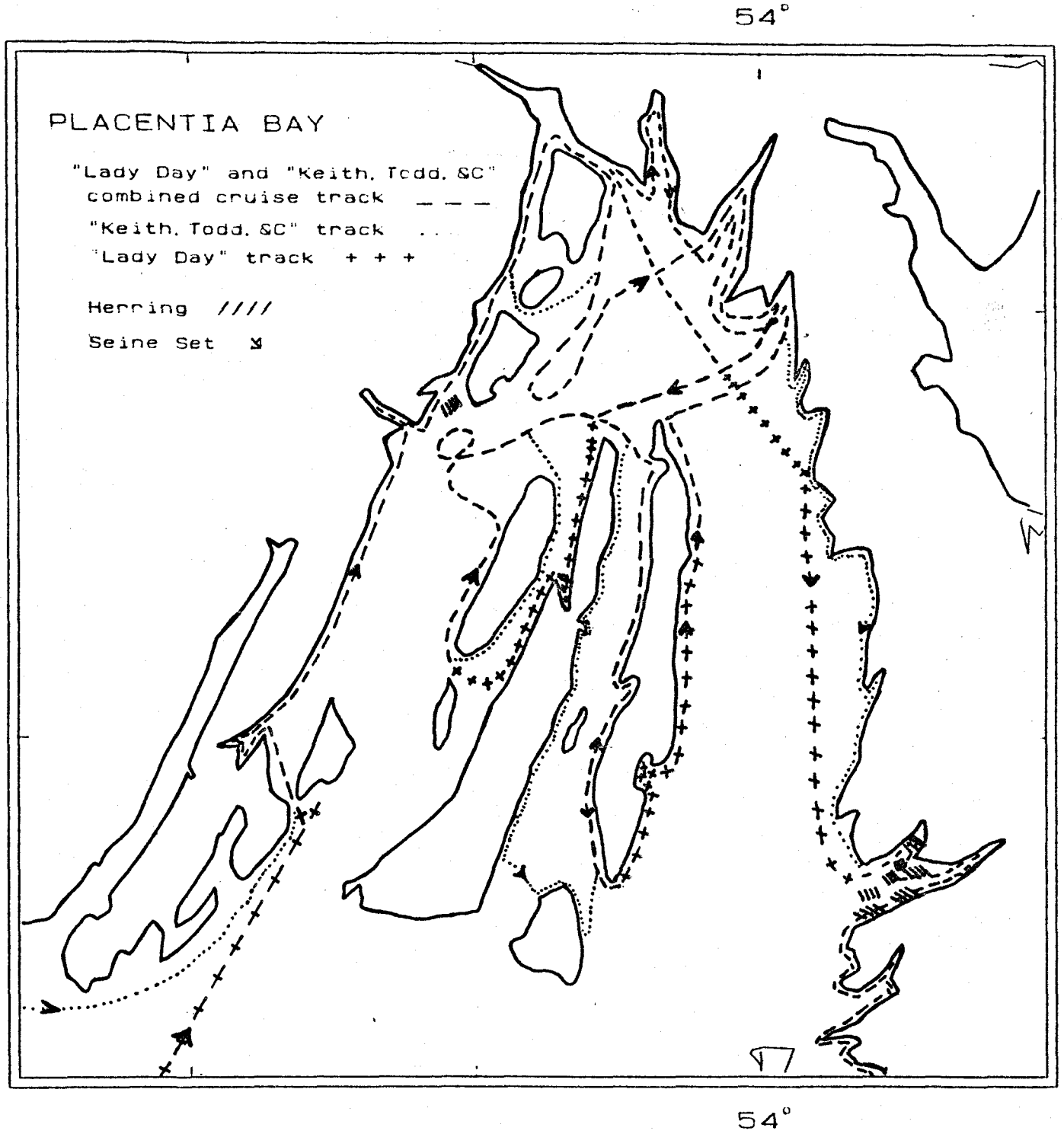

Fig.4 "Lady Day" and "Keith, Todd, &C" cruise tracks, herring markings, and set locations, Placentia Bay.

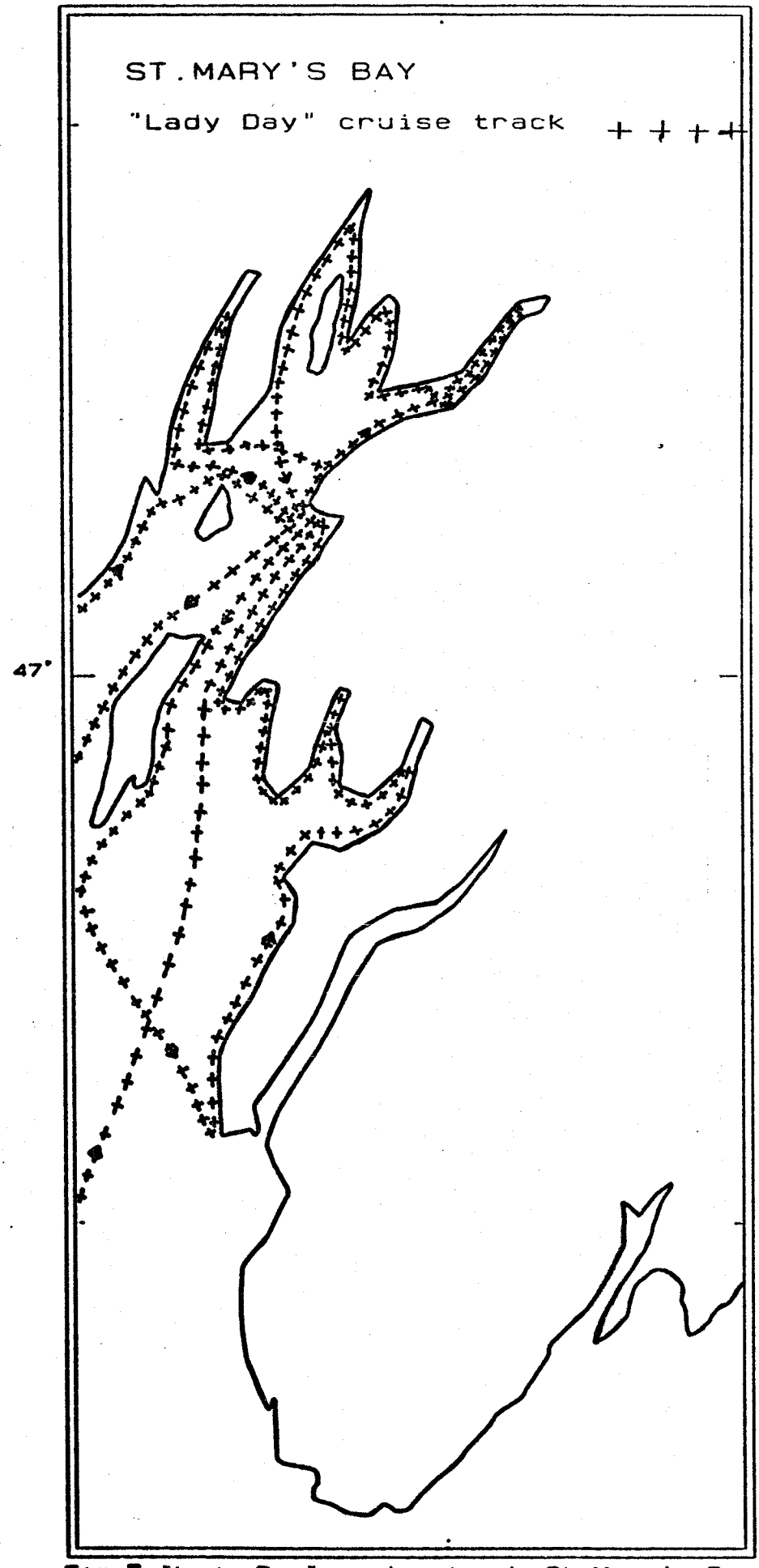

Fig. 5 "Lady Day" cruise track, St. Mary's Bay.

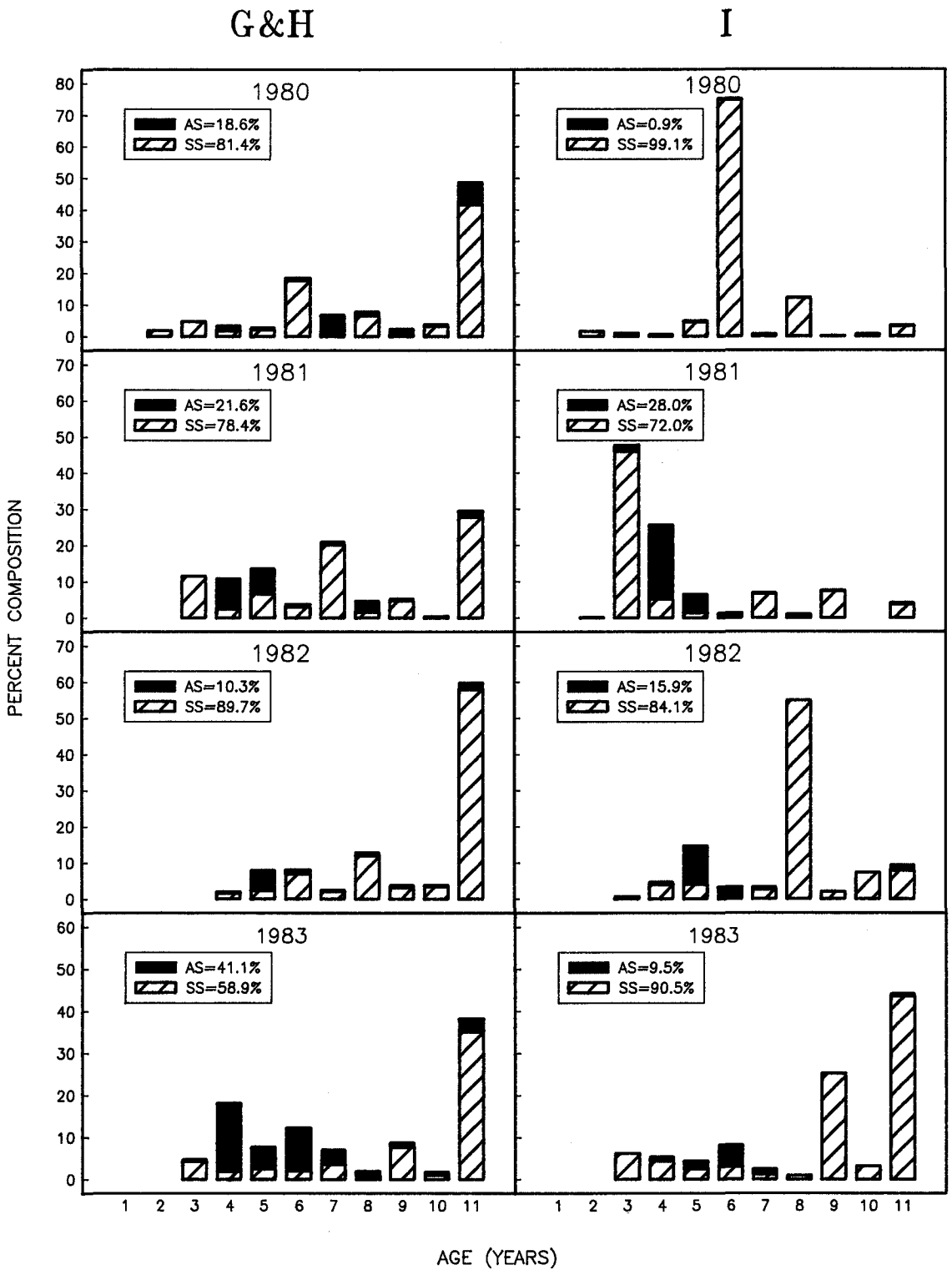

Fig.6. Age composition of herring from commercial fishery, St. Mary's Bay – Placentia Bay, and Fortune Bay, 1980–83.

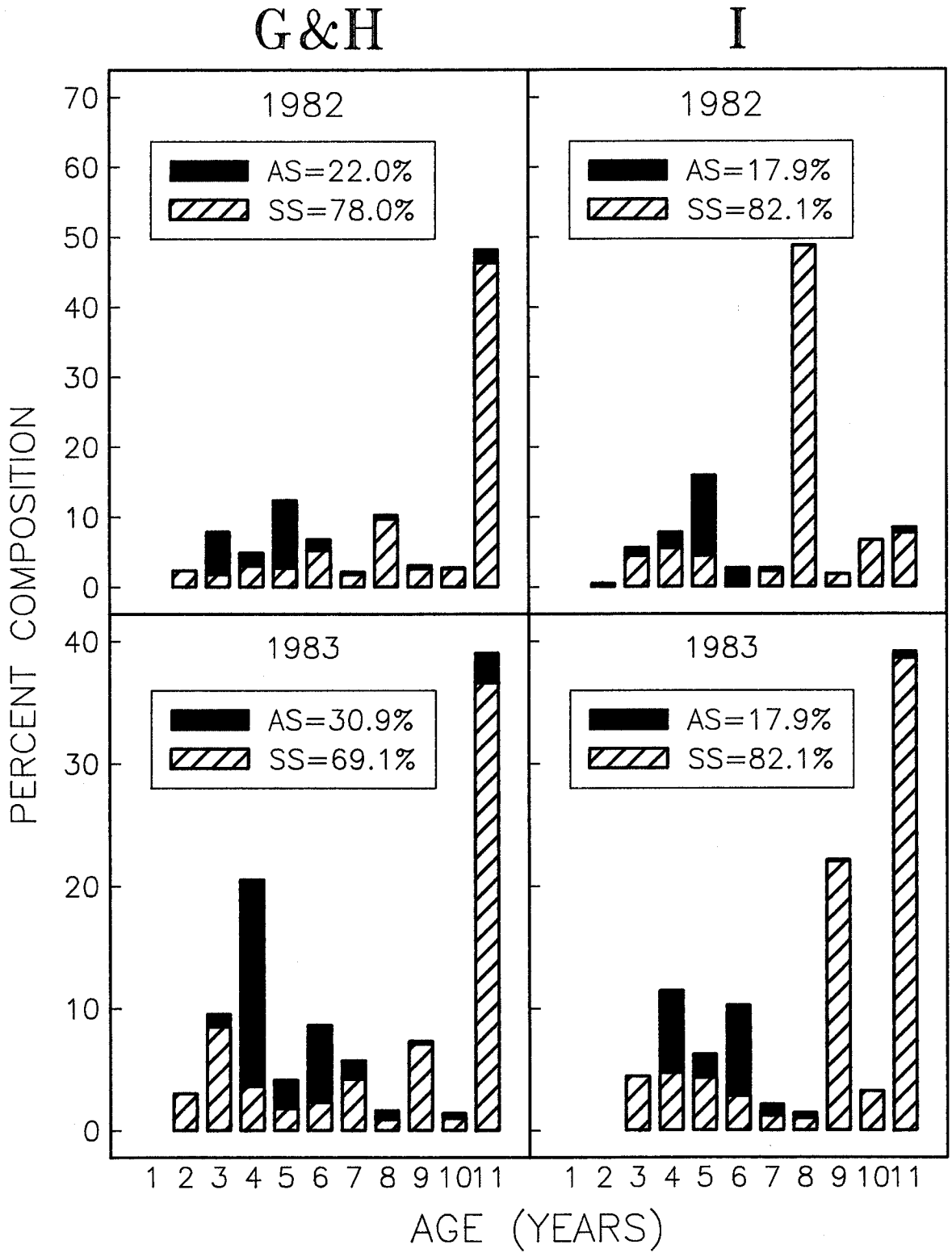

Fig.7. Age composition of herring from research gillnets, St. Mary's – Placentia Bays and Fortune Bay, 1982–83.

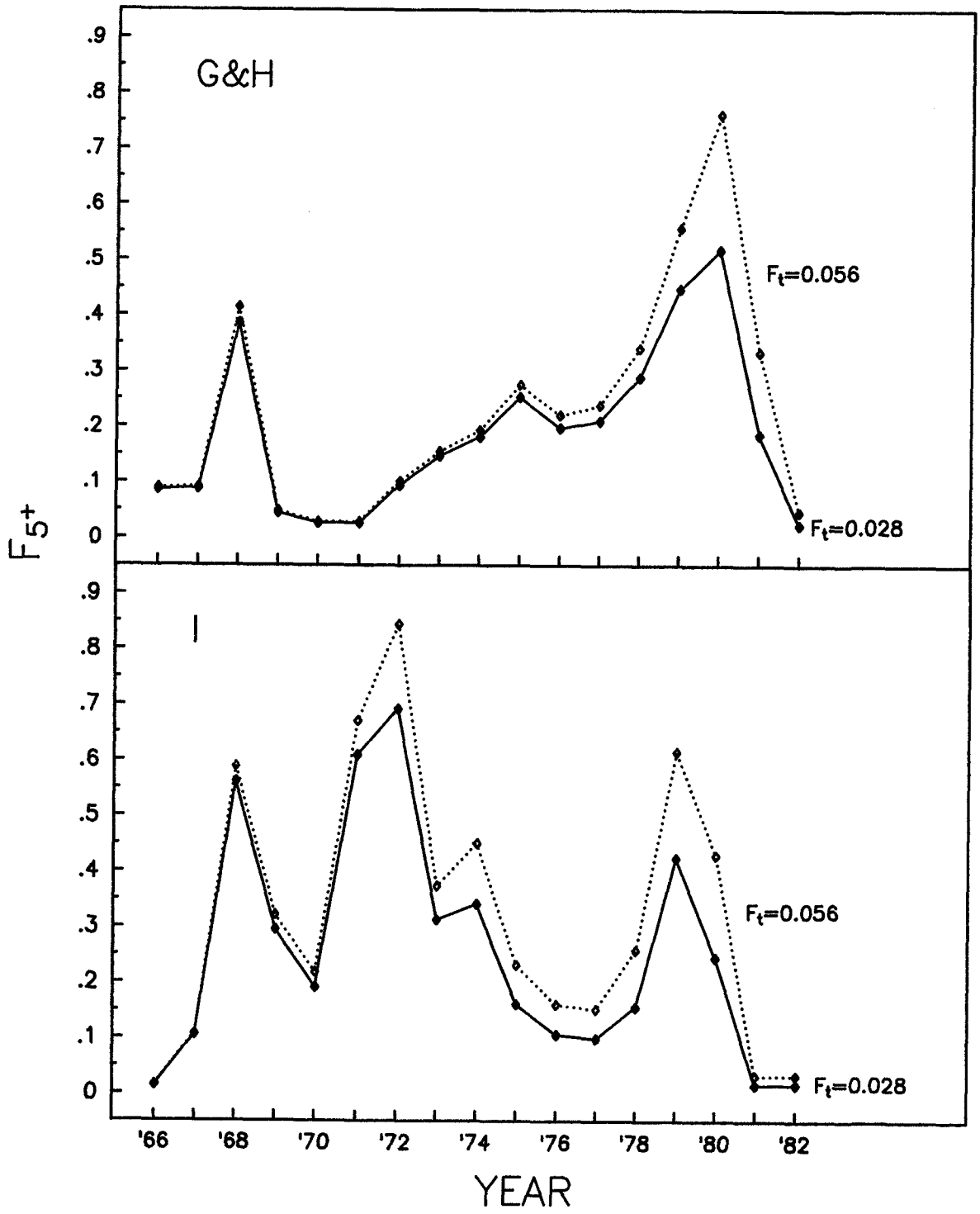

Fig.8. Fishing mortality (F_{5+}) versus time (1966–82) for southeast coast Newfoundland herring stocks.

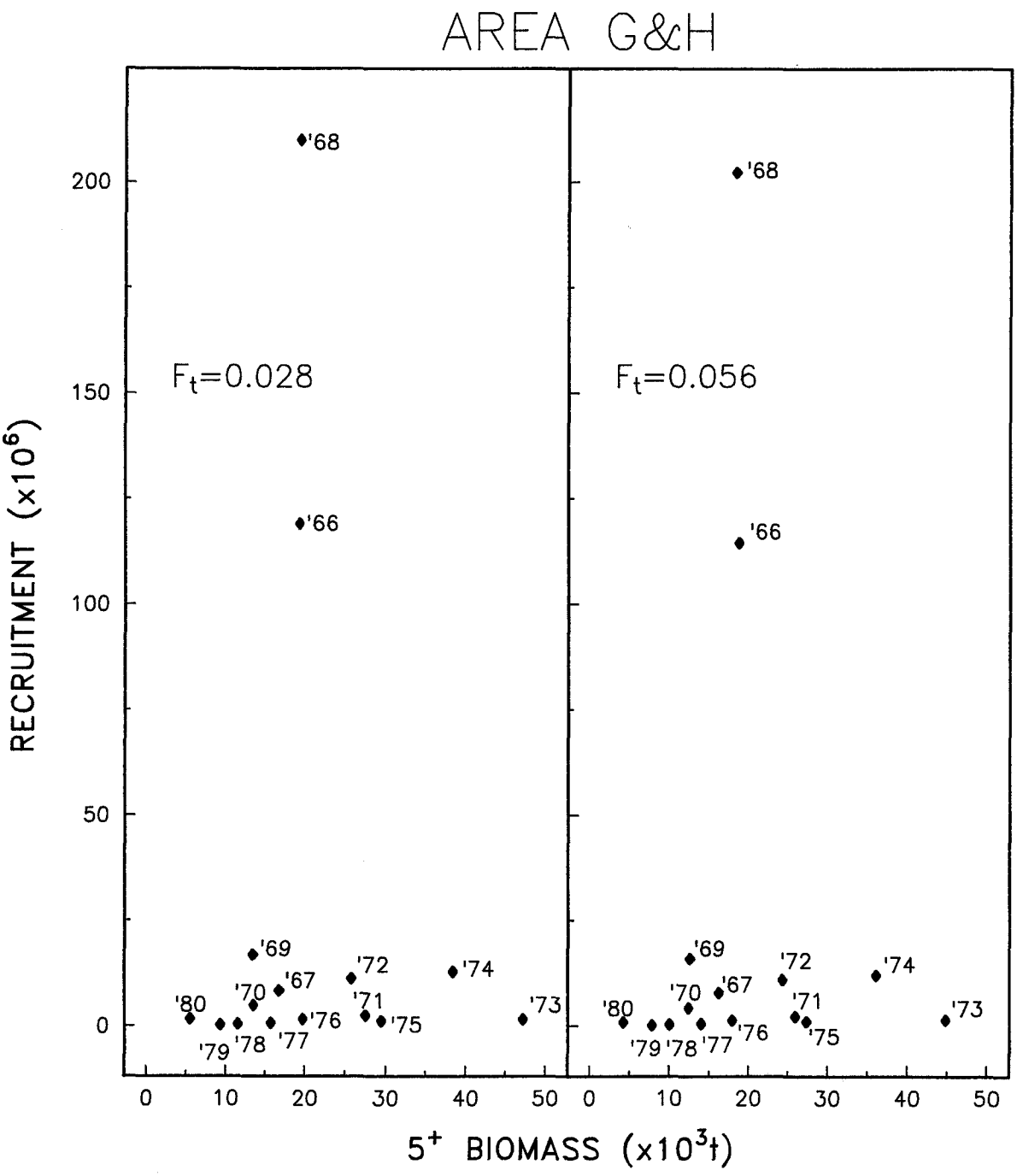

Fig.9. Recruitment vs. spawning biomass for Placentia Bay – St. Mary's Bay, using two options of F_t.

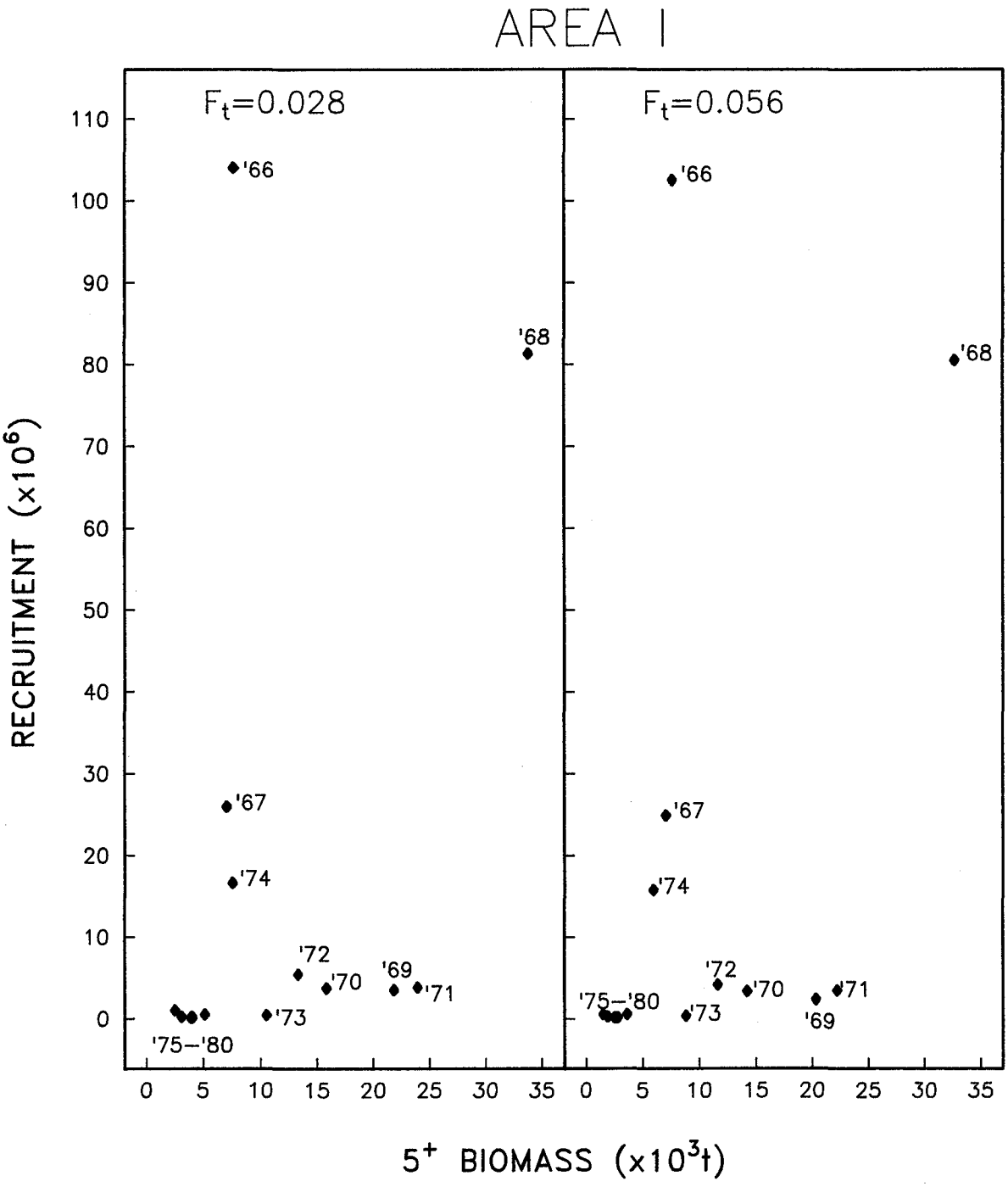

Fig.10. Recruitment vs. spawning biomass for Fortune Bay, using two options of F_t.

Appendix 1. Calculation of the 1981 partial recruitment vector for fall-spawning herring. Gillnet selectivities are based on empirical selectivity curves given in Olsen (1959) and purse-seine selectivities have been estimated from the mean F vector of purse-seine catches for the period 1973-76.

	Partial Recruitment (PR) rate (%)		
Age-Group	P. Seine	Gillnet	Weighted Mean (%)
2	<1	<1	<1
3	<1	<1	<1
4	30	62	36
5	70	92	74
6	100	100	100
7	93	99	94
8	87	92	88
9	80	85	81
10	73	72	72
11+	66	40	61
Weighting factor	82	18	

Appendix 2. Catch-rate (t per landing) statistics for Placentia Bay-St. Mary's Bay herring as derived from gillnet catches (C) (t) and landings (L).

	April			May			June			Mean catch-rate	Index of change in gang size*	Adjusted catch-rate
Year	C	L	C/L	C	L	C/L	C	L	C/L	(t/landing)		(t/landing)
1977	74.47	91	.818	124.21	142	.875	11.46	23	.498	0.821	1.02	.805
1978	49.06	139	.353	216.04	505	.428	44.75	84	.533	0.426	1.00	.426
1979	62.61	162	.386	122.74	261	.470	29.75	38	.783	0.467	1.19	.392
1980	102.25	250	.409	135.88	438	.310	42.38	95	.446	0.358	1.31	.273
1981	96.11	217	.443	13.52	66	.205	-	-	-	0.387	1.72	.225

* From Wheeler and Winters 1983

Appendix 3. Calculation of total instantaneous mortality rates (Z) of Placentia Bay-St. Mary's Bay herring from gillnet catch rate data.

	C_t ('000) in year				
Age-Group	1977	1978	1979	1980	1981
3	10.4	4.2	14.7	-	4.0
4	4.8	94.6	60.2	69.9	4.5
5	86.0	19.0	171.8	10.3	103.9
6	17.7	70.3	11.1	294.4	15.9
7	10.0	25.5	135.1	16.8	87.0
8	267.0	5.8	4.5	125.2	12.4
9	804.1	119.6	16.0	20.6	21.3
10	38.6	974.2	103.2	123.6	6.0
11+	451.2	513.2	1141.2	981.5	397.1
Total GN Catch (t)	609	704	639	691	271
Catch/Rate (t/landing)	.806	.426	.392	.273	.225
Effort (No. landings)	756	1653	1630	2531	1204
$\sum 5^+$	1675	1728	1582	1572	644
$\sum 6^+$	-	1709	1411	1562	540
Z_{5+}	0.76	0.19	0.45	0.33	

Appendix 4: Results of cohort analysis for Placentia Bay-St. Mary's Bay spring spawning herring using $F_t = 0.013$. Herring Area G&H-Fishing Mortalities.

	Year																	
Age	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
2	.000	.000	.022	.000	.002	.000	.000	.025	.074	.039	.022	.039	.014	.102	.172	.002	.000	.000
3	.023	.000	.033	.005	.013	.003	.012	.058	.118	.235	.298	.114	.177	.494	.684	.405	.002	.002
4	.019	.066	.004	.005	.048	.017	.129	.006	.054	.298	.323	.165	.210	.475	.170	.165	.006	.005
5	.019	.036	.301	.009	.007	.029	.137	.137	.011	.051	.207	.198	.214	.439	.522	.210	.016	.012
6	.018	.064	.119	.051	.017	.011	.091	.159	.181	.197	.105	.125	.245	.261	.473	.327	.021	.013
7	.143	.116	.199	.026	.049	.012	.066	.166	.168	.268	.153	.026	.128	.429	.241	.219	.028	.013
8	.150	.154	.200	.022	.033	.024	.034	.022	.219	.078	.165	.278	.070	.253	.694	.178	.012	.012
9	.077	.065	.508	.029	.036	.008	.114	.014	.040	.184	.146	.162	.214	.057	.169	.234	.035	.010
10	.033	.063	.727	.104	.013	.014	.056	.048	.030	.136	.179	.137	.241	.337	.296	.036	.016	.011
11^+	.120	.112	.827	.085	.016	.013	.055	.058	.087	.154	.178	.177	.218	.293	.253	.057	.010	.006
F_{2+}	.053	.063	.103	.014	.015	.010	.106	.121	.151	.220	.152	.157	.209	.325	.313	.107	.008	
F_{3+}	.058	.075	.271	.015	.040	.010	.108	.123	.159	.223	.181	.160	.219	.332	.319	.112	.011	
F_{5+}	.096	.099	.372	.048	.027	.025	.089	.134	.163	.220	.166	.171	.223	.320	.315	.098	.012	

Appendix 4 (Cont'd.)

Herring Area G&H-Population Numbers

	Year																	
Age	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
2	11383.	18204.	161644.	11724.	278387.	22969.	7750.	3480.	15497.	2128.	18162.	1511.	2329.	999.	929.	607.	4324.	8488.
3	51355.	9319.	14903.	129419.	9598.	227494.	18805.	6345.	2780.	11787.	1675.	14540.	1190.	1879.	739.	640.	496.	3539.
4	6212.	41081.	7629.	11804.	105390.	7759.	185752.	15209.	4900.	2022.	7629.	1018.	10617.	816.	939.	305.	350.	405.
5	6731.	4992.	31497.	6220.	9616.	82274.	6248.	133645.	12382.	3801.	1228.	4522.	706.	7048.	416.	648.	212.	285.
6	9901.	5408.	3944.	19077.	5044.	7819.	65449.	4459.	95421.	10023.	2956.	817.	3037.	467.	3722.	202.	430.	171.
7	15807.	7958.	4155.	2868.	14840.	4061.	6330.	48922.	3114.	65159.	6736.	2179.	590.	1946.	295.	1899.	119.	345.
8	10188.	11212.	5802.	2787.	2288.	11566.	3285.	4851.	33937.	2155.	40809.	4734.	1738.	425.	1038.	190.	1249.	95.
9	2043.	7181.	7867.	3888.	2232.	1812.	9241.	2599.	3886.	22312.	1633.	28325.	2936.	1327.	271.	424.	130.	1010.
10	1473.	1549.	5511.	3875.	3094.	1762.	1472.	6752.	2098.	3056.	15199.	1155.	19725.	1940.	1027.	187.	275.	103.
11^{+}	9787.	8272.	7243.	4772.	6444.	7687.	7634.	7051.	10714.	9708.	8874.	16383.	11992.	20484.	13542.	9148.	7215.	6053.
B_{2+}	27031.	24727.	35413.	34397.	49356.	61941.	65835.	55360.	44668.	35388.	26316.	21402.	17293.	12878.	8765.	5290.	4563.	4837.
B_{3+}	26178.	23361.	22966.	33447.	35158.	60195.	65246.	55071.	43568.	35205.	24990.	21283.	17107.	12779.	8667.	5241.	4135.	3996.
B_{5+}	17143.	14815.	19198.	12320.	12736.	28400.	27057.	50893.	42082.	32977.	22917.	18797.	14375.	12292.	8312.	5066.	3971.	3320.

Appendix 5. Results of cohort analysis for Placentia Bay-St. Mary's Bay autumn-spawning herring using F_t = 0.085.

Herring Area G&H-Fishing Mortalities

Age	Year												
	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
2	.052	.000	.001	.001	.000	.001	.000	.001	.003	.000	.000	.001	.001
3	.001	.000	.001	.022	.006	.001	.001	.003	.001	.004	.000	.000	.001
4	.005	.001	.005	.041	.186	.003	.004	.006	.013	.018	.052	.040	.031
5	.001	.001	.003	.133	.044	.173	.133	.180	.094	.083	.394	.231	.063
6	.013	.001	.049	.024	.073	.168	.575	.187	.269	.100	.324	.242	.085
7	.053	.031	.031	.073	.022	.109	.147	.182	.356	.137	.254	.396	.080
8	.042	.029	.023	.047	.086	.273	.448	.038	.765	.138	.794	.480	.075
9	.074	.010	.028	.071	.027	.206	.028	.376	.075	.151	.199	1.966	.069
10	.037	.025	.023	.029	.057	.106	.118	.057	.141	.041	.059	.431	.061
11^+	.134	.033	.055	.095	.125	.159	.102	.057	.102	.023	.116	.309	
F_{2+}	.058	.019	.029	.065	.078	.112	.070	.054	.082	.042	.084	.084	.026
F_{3+}	.058	.021	.031	.069	.093	.123	.113	.058	.085	.065	.163	.096	.029
F_{5+}	.065	.024	.038	.076	.092	.161	.157	.110	.160	.073	.289	.399	.037

Appendix 5 (Cont'd.)

Herring Area G&H-Population Numbers

Age	Year												
	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
2	3026.	2517.	1500.	1130.	2627.	1198.	5875.	903.	362.	4083.	7700.	1587.	1299.
3	1270.	2350.	2060.	1227.	924.	2150.	980.	4809.	738.	295.	3342.	6303.	1299.
4	1856.	1039.	1924.	1686.	983.	752.	1758.	802.	3926.	604.	241.	2735.	5160.
5	1690.	1512.	850.	1567.	1324.	668.	614.	1433.	653.	3172.	485.	187.	2151.
6	3193.	1383.	1236.	694.	1123.	1037.	460.	440.	980.	486.	2390.	268.	122.
7	5536.	2581.	1131.	964.	554.	855.	718.	212.	299.	613.	360.	1415.	172.
8	2702.	4300.	2049.	898.	734.	444.	627.	507.	145.	171.	438.	229.	780.
9	1651.	2122.	3418.	1639.	702.	551.	277.	328.	400.	55.	122.	162.	116.
10	2355.	1256.	1720.	2723.	1249.	559.	367.	220.	185.	304.	39.	82.	19.
11^+	7252.	7047.	6580.	6468.	6974.	6002.	4601.	3391.	2629.	1825.	1641.	1068.	456.
B_{2+}	8491.	7250.	6375.	5528.	4726.	3950.	3390.	2966.	2597.	2287.	2541.	2518.	2270.
B_{3+}	8339.	7124.	6300.	5472.	4594.	3890.	3096.	2921.	2579.	2083	2156.	2438.	2205.
B_{5+}	7822.	6621.	5667.	4992.	4287.	3467.	2635.	2143.	1737.	1929.	1676.	1099.	1056.