Canadian Atlantic Fisheries
Scientific Advisory Committee

CAFSAC
Res. Doc. 80/75

An Evaluation of the Current Status of the St. Mary's-Placentia Bay Herring Stock

by

J. A. Moores and G. H. Winters
Research and Resource Services
Department of Fisheries and Oceans
P.O. Box 5667
St. John's, Newfoundland
A1C 5X1

Abstract

Catches from the St. Mary's-Placentia Bay herring stock declined to 2400 mt in 1980. The 1968+ year-classes remained dominant contributing 52% of the catch with the 1974 year-class accounting for 22%. The proportion of catch represented by each of these year-classes varied greatly between the two bays within this stock area. The 1974 year-class has appeared significantly in Placentia Bay since 1977 and represented 29% of the 1980 catch while accounting for only 8% of the St. Mary's Bay catch in 1980.

Three sources of catch rate data were examined: (1) ring net landing slips, (2) ring net log records, and (3) gillnet landing slips. These data were used to calculate total mortality rates within the stock. The log records and gillnet data appear to be most reliable particularly for the St. Mary's Bay time series and gave Paloheimo Z_{6+} values (1979-80) of 0.46 and 0.60 respectively.

Cohort analysis was performed at these and the average mortality levels and in all cases indicated a decline in the stock with the spawning biomass declining to < 16% of peak levels.

Résumé

Les prises prélevées à même les stocks de harengs des baies Ste-Marie et de Placentia ont diminué, passant à 2 400 tm en 1980. Les classes d'âge de 1968+ continuent d'être dominantes, contribuant 52%, celle de 1974 responsable de 22% des prises. La proportion des prises représentée par chacune de ces classes d'âge varie beaucoup d'une baie à l'autre. La classe d'âge de 1974 est présente en assez grande abondance dans la baie de Placentia depuis 1977; elle représentait 39% des prises de 1980, alors que cette même année, elle ne contribuait que 8% de celles de la baie Ste-Marie.

Nous avons examiné trois sources de données: (1) les fiches de débarquements des bolinches, (2) les journals de bord de ces dernières et (3) les fiches de débarquement des filets maillants. Ces données ont servi à calculer les taux de mortalité totale parmi ce stock. Les données des journals de bord et des filets maillants semblent être les plus fiables, surtout en ce qui a trait à la série de la baie Ste-Marie. Les valeurs de Z_{6+} de Paloheimo (1979-80) sont de 0,46 et 0,60 respectivement.

Nous avons effectué des analyses de cohortes à ces niveaux ainsi qu'à d'autres. Dans tous les cas, elles indiquent une diminution du stock, la biomasse de ponte tombant à moins de 16% des niveaux les plus élevés.

Introduction

Between 1945 and 1950 herring landings from the St. Mary's-Placentia Bay area averaged 15,000 mt (Templeman 1966). The highest catch recorded since that period was 6,700 mt in 1974 (Winters and Moores 1979). Landings declined to 2,400 mt in 1980.

The purse seining component in this area has been under quota control since 1973. In recent years purse seiners in excess of 65' LOA have been eliminated from St. Mary's Bay and their allocations substantially reduced in Placentia Bay. Since 1977 the major contributor to the catch has been small purse seiners (ring netters) of less than 65' LOA. In 1980 all components of the fishery, both mobile and fixed gear, were placed under quota regulation.

1980 catch and age composition

The 1980 provisional catch of 2400 mt represented a 1200 mt drop in catch from the 1979 catch of 3600 mt and fell 100 mt short of the 1980 TAC of 2500 mt. The St. Mary's Bay catch of 1010 mt represent 42% of the total catch with 1390 mt (58%) being taken in Placentia Bay (Table 1).

The catch composition from these two bays has been markedly different since 1977 (Fig. 2) with the 1968 year-class of spring-spawners remaining dominant in St. Mary's Bay while both the 1968 and 1974 year-classes have supported the fishery in Placentia Bay which at least during the winter period exploits both stock components.

In St. Mary's Bay the 1968 year-class contributed 82% of the catch in 1980 while the 1974 year-class represented only 8% of the catch. In Placentia Bay the 1974 year-class, which had been dominant from 1977 to 1979, represented 29% of the catch in 1980 with 1968+ year-classes being dominant at 36%. In terms of total removals from the stock the 1968+ year-classes continued to be dominant at 52% followed by the 1974 year-class at 22%.

Catch and Effort Statistics

Three measures of effort were available: (1) ring net landing slip data, (2) ring net log records, and (3) gill net landing slip data.

1. Ring net landing slip data

Information on the activity of the ring net fleet was available from landing slips for the period 1976 to 1980. The data were broken down by bay into four categories: (1) boats which had fished all years since 1976; (2) boats which have fished since 1978; (3) boats which have fished since 1979, and (4) all boats combined. These groupings differ somewhat from those used previously (Winters and Moores 1979) due to the replacement of vessels and the withdrawal of other vessels from the fishery. The data (Table 2) does not show any clear trends either within groups or between bays. This may partially be due to the failure of the landing slip data to give information on searching time, nor is it possible to evaluate learning within the fleet. An additional compounding factor is the shifting of effort from the inner part of Placentia Bay to the St. Lawrence area (Fig. 1) which has been occurring since 1978.

2. Ring net logs

Log records were available from the ring net fleet for the years 1979 and 1980 (Table 3). While there is a high degree of variability in the catch per landing day from month to month, both bays show a decline in the average catch rates from 1979 to 1980. These data should more accurately reflect stock abundance than the landing slip data as they include total searching time.

3. Gillnet landing slip data

An examination of gillnet catch rates was conducted for each bay using landing slip data from 1977 to 1980. While gillnet fisheries have occurred in most months of the year the April-June period has consistently represented the main fishing season and produces the bulk of the gillnet landings. Weighted average catch rates were calculated for April-June to compare the annual variation in catch rate. The results (Table 4) show a steady decline in St. Mary's Bay from 1977-1980 while in Placentia Bay catch rates increased from 1977 to 1979 and declined in 1980. This may reflect the recruitment of the 1974 year-class into the gillnet fishery in Placentia Bay whereas in St. Mary's Bay this year-class has not appeared in significant numbers. As the gillnets are deployed in traditional locations and are fished as fixed gear they are not subject to searching time as are the ring netters and therefore the landing slips should provide reasonable estimates of the gillnet catch rates. However, gang size may have increased in these areas during the late 1970's, as was reported for the east coast of Newfoundland by Wheeler and Winters (1980).

Calculation of Total Mortality(Z)

The age composition of the catch indicates that the St. Mary's Bay fishery exploits primarily old, mature fish and should therefore reflect the decline in abundance of these age groups. While the 1974 year-class is now fully mature its abundance in the two bays was greatly different and therefore only year-classes 1973 and older were included in the analysis. Using the various catch rate data series for St. Mary's Bay, Paloheimo Z values (Paloheimo 1961) ages 6+ were calculated for 1979-80. The variability in the ring net sales slip data generated negative mortality rates for all but one category (Table 5).

The ring net log data and the gillnet landing slip data gave 6^+ Z values of 0.46 and 0.60 respectively.

A similar analysis was performed for the Placentia Bay fishery but due to the large contribution from the 1974 year-class Paloheimo $\bar{Z}$ values for age 5+ were calculated. The ring net landing slip data gave variable results (Table 5) with $\bar{Z}$ values ranging from 0.22 to 0.63. The catch rates derived from the ring net log records gave a $\bar{Z}_{5+}$ of 0.84 which was higher than any of the values derived from the ring net sales slips and indicates the affect of the inclusion of searching time on the catch rates. The gillnet data gave a $\bar{Z}_{5+}$ of 0.42.

The tagging studies performed on this stock indicate a high degree of mixing during the winter purse seine fishery in Placentia Bay. Assuming the pattern has remained unchanged the ring net log records from the Placentia Bay fishery were used to estimate the mortality on the total stock and gave a $\bar{Z}_{5+}$ of 0.80.

The estimates of mortality derived using the various catch per unit effort series cover a wide range. Of these time series the ring net sales slip data appears to be the least reliable as no measure of the searching time is included. While the log records do account for this only two years data are available. The data sets for gillnet catch rates tend to be larger than for the other fleet components and hence estimates of mortality from the gillnet CPUE should perhaps be assigned greater significance. The St. Mary's Bay fishery has been more consistent over the last few years in terms of fleet composition and locations fished and therefore the data series from this area is probably a better indicator of changes in abundance than Placentia Bay.

1980 population estimate

The 1980 population size was examined using the two most reliable estimates of 1979-80 mortality (a) $\bar{z}$ of St. Mary's gillnet CPUE (because of their fairly large data set) (b) mortality rate estimated from the St. Mary's Bay ring net fleet log records (because of its temporal and spatial consistency over time. The Placentia Bay purse seine age composition was felt to most accurately reflect the population age structure as stock mixture would be greatest during this fishery and was used to transform the St. Mary's Bay 7^+ population number into a total population size at age (Table 6). These population sizes are illustrative as the represent mean population sizes. The population size ranged from 18.4×10^6 individuals to 26.7×10^6 individuals.

Cohort Analysis

Using the partial recruitment rates (Table 6) generated from the mean 1980 population structure, cohort runs were performed to generated a mean 1979-80 6^+ Z equivalent to the Paloheimo Z values calculated from the gillnet data, the ring net logs and the average of the two. These options were generated at F_T values of 0.36, 0.47 and 0.60 and the results are shown in Tables 7, 8 and 9.

Peak biomass (2^+) levels occurred in 1971 and have declined since then. The 1980 biomass levels are the lowest observed for the period covered by the analysis (1969-1980). The 5^+ biomass in 1980 ranged from 11-16% of the peak levels of 1973.

Recruitment to the stock has been generally poor since the strong 1968 year-class. The 1974 year-class which was previously estimated to be 1/5th the size of the 1968 year-class now appears to be smaller and is estimated at about 1/10th the strength of the 1968 year-class.

The F_5+ values show low fishing mortalities from 1969 to 1972. Since 1976 the mortalities increased to a peak in 1979, decreasing slightly in 1980.

To try and refine the estimate of F_T a comparison of 5+ biomass with St. Mary's Bay gillnet CPUE for 1977-80 was performed. The analysis (Table 10) show a trend of increasing R^2 with each increasing option of F_T and does not provide any power of discrimination.

Catch Projection

Catch projections were performed for each of the three options using the historical partial recruitment rate (Winters and Moores 1979), the 1980 average weight values and an F opt value of 0.30 (Winters and Moores 1979). Recruitment at age 2 in the projection was set at 5.0×10^6 recruits. The projections (Table 11) show a continued stock decline. Adjusting the 1981 catches to account for autumn spawners and seasonal changes in weight (ratio actual 1980 catch/calculated 1980 catch = 1.14) gives the following 1981 TAC levels:

	F		
	0.36	0.47	0.60
TAC (mt) 1981	2134	1582	1194
5+ biomass (mt) 1982	5380	3980	3000

Discussion

The St. Mary's- Placentia Bay herring stock has been declining since 1973 when the 1968 year-class became fully recruited to the fishery. Recent year-classes have generally been poor with the exception of the moderate 1974 year-class, however this year-class has only contributed significantly to the catch in Placentia Bay. As the stock has declined searching activity has increased resulting in the development of a fishery in the St. Lawrence area. This area

is adjacent to the demarcation point between the St. Mary's-Placentia and Fortune Bay stocks.

With the poor recruitment pattern the decline will contine at least for the immediate future. The present spawning stock levels (5^+) are the lowest observed for the time series and represent < 16% of peak levels. While no relationship between stock size and recruitment has been observed for this stock the current low levels are a matter of concern. In light of the present stock situation, presented by all three options, and as the gillnet data would be least susceptable to learning factors the most conservative option ($F_T = 0.60$) probably provides the most reasonable representation of the current stock status in St. Mary's and Placentia Bays.

Acknowledgments

The authors wish to thank the staff of the Pelagic Section for collecting and collating the basic data on which the above analyses were based. Mr. C. I. Barbour and Mr. R. Chaulk were responsible for age determation.

References

Paloheimo, J. E. 1961. Studies on estimates of mortalities. Comparison of a method described by Beveiton and Holt and a new linear formula. J. Fish. Res. Board Can. 18: 645-662.

Templeman, W. 1966. Marine Resources of Newfoundland. Bull. Fish. Res. Board Can. 154.

Wheeler, J. P., and G. H. Winters. 1980. Analysis of the stock size and yield of east coast of Newfoundland herring stocks. CAFCAS Res. Doc. 80/52.

Winters, G. H., and J. A. Moores. 1979. Estimation of biomass and yield of the St. Mary's-Placentia Herring Stock complex. CAFSAC Res. Doc. 79/36.

Table 1. Herring landings by gear, St. Mary's-Placentia Bays, 1976-80.

Year	Area	Gear					
		P. Seine	R. Net	B. Seine	Gillnet	Trap	Total
1976	SMB	-	920	158	352	25	1455
	PB	2056	172	242	177	-	2647
	Total	2056	1092	400	529	25	4102
1977	SMB	-	1132	221	531	29	1912
	PB	740	524	14	78	-	1356
	Total	740	1655	235	609	29	3268
1978	SMB	-	1523	67	489	3	2082
	PB	558	613	30	212	34	1447
	Total	558	2136	97	701	37	3529
1979	SMB	-	1570	131	332	9	2042
	PB	359	891	17	307	1	1575
	Total	359	2461	148	639	10	3617
1980*	SMB	-	643	17	339	13	1012
	PB	182	861	11	309	30	1393
	Total	182	1504	28	648	43	2405

* provisional

Table 2. Catch per unit effort data (mt/landing) for ring netters in Placentia and St. Mary's Bays (from landing slips).

Placentia Bay.

	A. Boats common '76-80					B. Boats common '78-80					C. Boats common '79-80					D. All boats combined				
Year	J	F	M	A	Ave[1]	J	F	M	A	Ave[1]	J	F	M	A	Ave[1]	J	F	M	A	Ave[1]
1976	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	29.1	15.9	-	-	24.7
1977	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.0	8.3	8.7	11.4	8.9
1978	-	-	-	-	-	7.4	5.1	9.6	-	7.0	-	-	-	-	-	5.3	7.0	7.5	44.7	8.2
1979	-	-	-	-	-	11.0	27.1	-	-	20.4	22.2	25.4	-	-	22.7	16.2	22.0	21.3	-	19.0
1980	-	-	-	-	-	11.2	17.2	7.8	-	13.0	30.6	17.8	10.9	-	21.7	18.0	18.1	9.0	-	16.7

St. Mary's Bay.

	A. Boats common '76-80					B. Boats common '78-80					C. Boats common '79-80					D. All boats combined				
Year	F	M	A	M	Ave	F	M	A	M	Ave	F	M	A	M	Ave	F	M	A	M	Ave
1976	9.6	5.3	10.6	8.3	8.4	-	-	-	-	-	-	-	-	-	-	9.3	8.1	12.5	9.1	10.5
1977	-	8.9	20.3	-	18.4	-	-	-	-	-	-	-	-	-	-	-	13.3	22.8	-	21.6
1978	-	18.3	10.6	-	12.8	-	22.1	14.9	-	15.8	-	-	-	-	-	-	19.3	11.7	-	13.4
1979	-	9.4	6.4	-	8.2	5.5	12.0	9.2	-	10.7	15.9	26.8	9.6	-	19.8	14.4	15.7	8.2	-	13.2
1980	-	15.8	26.3	-	18.7	-	27.0	22.8	-	26.2	-	17.0	24.0	-	18.1	-	19.6	22.0	-	20.1

[1] Ave = weighted average

Table 3. Catch per unit effort (mt/operating day) from ring net log records.

Area	Year	Month				Average	Weighted average
		Jan.	Feb.	Mar.	April		
St. Mary's Bay	1979	-	16.4	7.5	5.0	9.6	7.0
	1980	-	-	3.5	10.7	7.1	5.0
Placentia Bay	1979	12.0	8.4	27.3	-	15.9	10.9
	1980	3.4	11.3	1.3	-	5.3	5.6

Table 4. Catch per unit effort (mt/landing) data for St. Mary's and Placentia Bays from gillnet sales slips.

Area	Year	Month									Weighted average April-June
		Jan.	Feb.	Mar.	April	May	June	Oct.	Nov.	Dec.	
St. Mary's Bay	1977	.76	.61	.83	.82	.92	.52	-	.69	1.08	0.85
	1978	-	-	-	.38	.59	.53	-	-	-	0.54
	1979	-	-	-	.40	.32	.82	.22	-	-	0.42
	1980	-	-	-	.30	.25	.11	-	-	-	0.26
Placentia Bay	1977	.57	-	-	-	.19	.08	-	.25	.10	0.18
	1978	-	-	-	.31	.28	.62	-	.36	.46	0.29
	1979	.31	.55	.61	.37	.60	.35	.20	-	-	0.52
	1980	-	.65	-	.45	.36	.47	-	-	-	0.41

Table 5. Paloheimo $\bar{Z}$ values calculated from various sets of catch rate data for St. Mary's Bay (ages 6+) and for Placentia Bay (ages 5+) for the period 1979-80.

Catch rate series	Area	
	St. Mary's Bay	Placentia Bay
Gillnets	0.60	0.42
Ringnet logs	0.46	0.84
Ringnet landing slips		
Category[1] (A)	-0.70	-
(B)	-0.78	0.63
(C)	0.21	0.22
(D)	-0.30	0.31

[1] see text for explanation of categories

Table 6. Illustrative 1980 population structure of the St. Mary's-Placentia herring stock derived from two estimates of mortality and the resultant partial recruitment rates.

Age	Z 0.46	Z 0.60	PR
2	1,148	793	.27
3	3,123	2,158	.24
4	374	258	1.07* [.25]
5	1,334	922	.26
6	8,167	5,643	.38
7	347	240	.40
8	2,268	1,567	.53
9	160	110	.61
10	960	664	.64
11+	8,807	6,086	1.00
Total	26,688	18,441	

* the PR value for age 4 appears anomalous and a value of 0.25 was used in the cohort analysis

Table 7. Results of cohort analysis for St. Mary's-Placentia herring for the period 1969-80, F_T = 0.36.

	Population Numbers x10^{-5}											
	Year											
Age	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
2	189	2553	221	84	31	208	24	326	40	33	52	15
3	1203	154	2086	181	68	25	161	19	264	32	27	42
4	138	979	125	1703	147	53	18	112	13	204	25	16
5	104	113	760	102	1208	120	41	10	77	9	151	18
6	135	84	92	602	74	868	93	32	7	57	7	103
7	60	107	68	74	448	27	581	61	24	5	41	5
8	61	48	81	56	54	303	16	349	43	20	3	28
9	67	50	39	64	42	31	196	12	239	26	15	2
10	46	54	40	32	47	32	24	129	8	161	18	12
11+	34	59	91	106	109	123	119	102	159	110	172	104
N_t2+	2037	4201	3603	3004	2228	1790	1273	1152	874	657	511	345
2+ Wgt. ('000 mt)	45.7	71.9	82.8	81.1	71.8	57.7	43.9	34.2	27.8	21.5	17.0	11.8
5+ Wgt. ('000 mt)	18.5	19.0	39.6	36.9	66.8	53.8	40.3	27.7	22.2	15.8	15.4	10.5
F_5+	.032	.024	.027	.091	.159	.179	.245	.165	.180	.194	.255	.209

Table 8. Results of cohort analysis for St. Mary's-Placentia herring for the period 1969-80, F_T = 0.47.

	Population Numbers x10^{-5}											
	Year											
Age	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
2	185	2469	209	71	30	188	22	276	32	28	41	12
3	1165	152	2017	171	58	24	145	17	223	26	23	33
4	133	948	123	1646	139	45	17	98	11	170	20	13
5	99	109	734	100	1162	113	34	9	66	8	123	14
6	130	80	88	581	73	830	87	27	6	47	5	81
7	53	102	65	72	431	26	550	57	20	4	34	4
8	55	42	78	53	52	289	15	324	39	16	3	22
9	62	45	34	61	39	29	184	11	219	23	12	2
10	44	50	36	28	45	31	23	120	7	144	15	9
11+	32	56	85	98	99	113	109	93	144	98	148	84
N_2+	1958	4053	3469	2881	2128	1688	1186	1032	767	564	424	274
2+ biomass ('000 mt)	43.7	69.1	79.6	77.9	68.6	54.6	41.1	31.1	24.7	18.7	14.3	9.3
5+ biomass ('000 mt)	17.4	17.8	37.8	35.3	64.0	51.2	37.8	25.5	20.1	13.9	13.0	8.3
F_5+	.034	.026	.028	.095	.167	.189	.263	.180	.202	.224	.312	.277

Table 9. Results of cohort analysis for St. Mary's-Placentia herring for the period 1969-80, F_T = 0.60.

	Population Numbers x10^{-5}											
	Year											
Age	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
2	183	2410	201	62	28	174	20	240	27	24	33	9
3	1139	150	1969	165	51	23	133	15	194	22	20	26
4	130	927	122	1607	134	39	16	89	10	146	17	10
5	96	106	717	98	1130	109	30	9	58	7	104	11
6	126	78	86	566	72	803	84	23	5	41	5	65
7	48	99	63	70	420	25	529	54	17	4	29	3
8	51	38	75	51	50	279	14	306	37	13	3	18
9	59	41	31	59	38	28	176	10	204	21	10	1
10	43	47	33	25	43	29	22	114	7	132	14	8
11+	31	54	81	92	92	105	103	87	134	89	132	69
N_2+	1906	3950	3378	2795	2058	1614	1127	947	693	499	367	220
2+ biomass ('000 mt)	42.2	67.1	77.4	75.6	66.4	52.5	39.1	28.9	22.6	16.7	12.4	7.6
5+ biomass ('000 mt)	16.5	17.0	36.6	34.2	62.0	49.3	36.0	24.0	18.5	12.6	11.3	6.8
F_5+	.036	.027	.029	.098	.172	.197	.278	.193	.222	.251	.371	.357

Table 10. Comparison of 5+ biomass from cohort with CPUE data from St. Mary's Bay gillnet landing slips.

Year	Gillnet CPUE	5+ biomass at F_T		
		0.36	0.47	0.60
1977	0.85	22,241	20,052	18,510
1978	0.54	15,785	13,896	12,566
1979	0.42	15,403	12,976	11,263
1980	0.26	10,453	8,283	6,751
R^2		0.965	0.978	0.984

Table 11. Catch projection for 1981 for St. Mary's-Placentia Bays (numbers $x10^{-5}$).

Age	F	F_T = 0.36			F_T = 0.47			F_T = 0.60		
		N_t '81	C_t '81	N_t '82	N_t '81	C_t '81	N_t '82	N_t '81	C_t '81	N_t '82
2	.03	50	1.3	50	50	1.3	50	50	1.3	50
3	.09	11	0.9	40	9	0.7	40	7	0.5	40
4	.15	32	4.0	8	24	3.0	6	18	2.3	5
5	.30	12	2.9	22	9	2.2	17	7	1.7	13
6	.30	13	3.2	7	10	2.4	6	8	1.8	4
7	.30	74	17.4	8	55	13.1	6	42	10.0	5
8	.30	3	0.8	45	2	0.6	34	2	0.4	26
9	.30	19	4.5	2	14	3.4	1	11	2.5	1
10	.30	1	0.3	12	1	0.2	9	1	0.2	7
11+	.30	67	15.9	42	49	11.5	30	35	8.4	22
W_t ('000 mt)		8.8	1.9	6.8	6.7	1.4	5.4	5.2	1.0	4.4

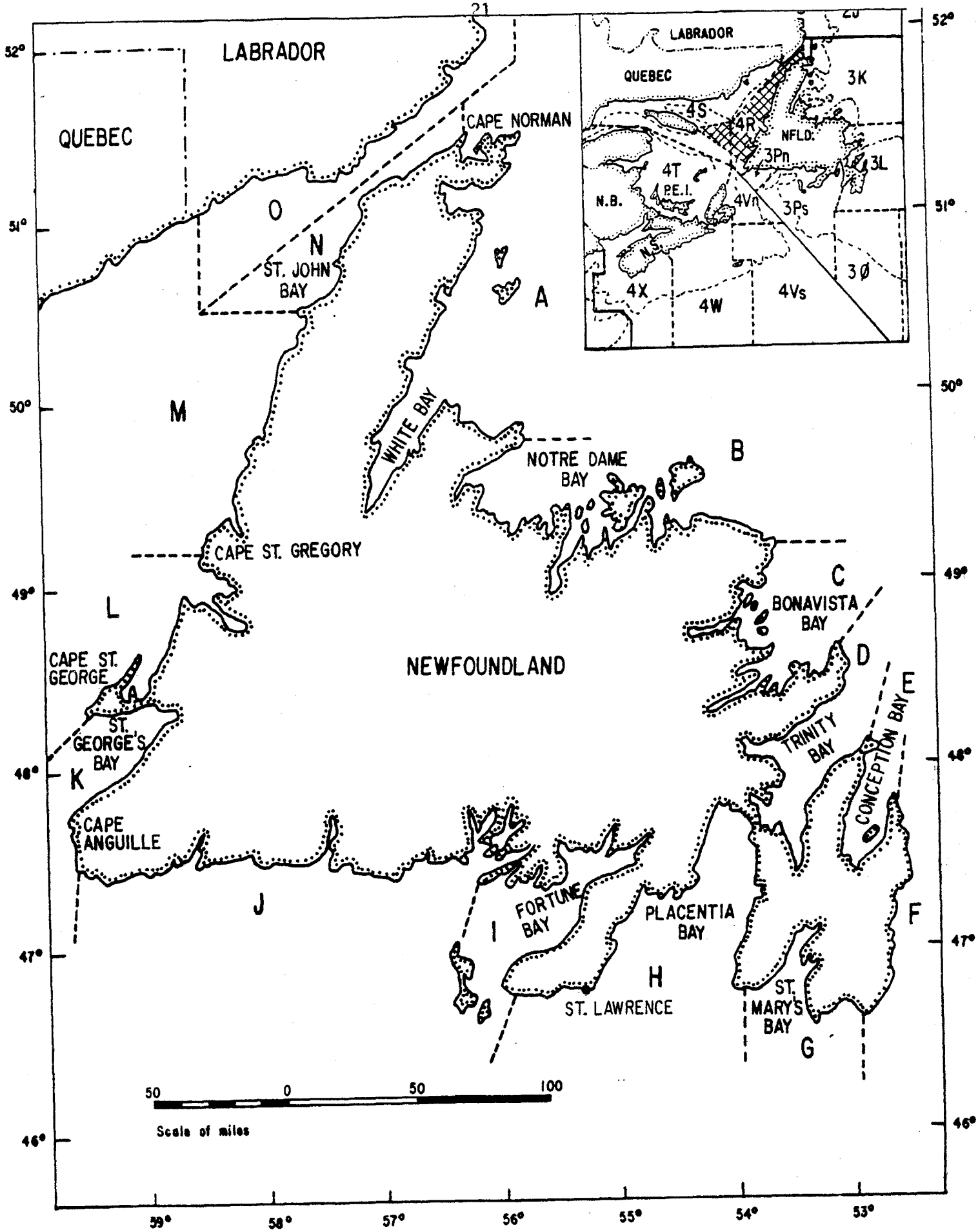

Fig. 1. Newfoundland area map.

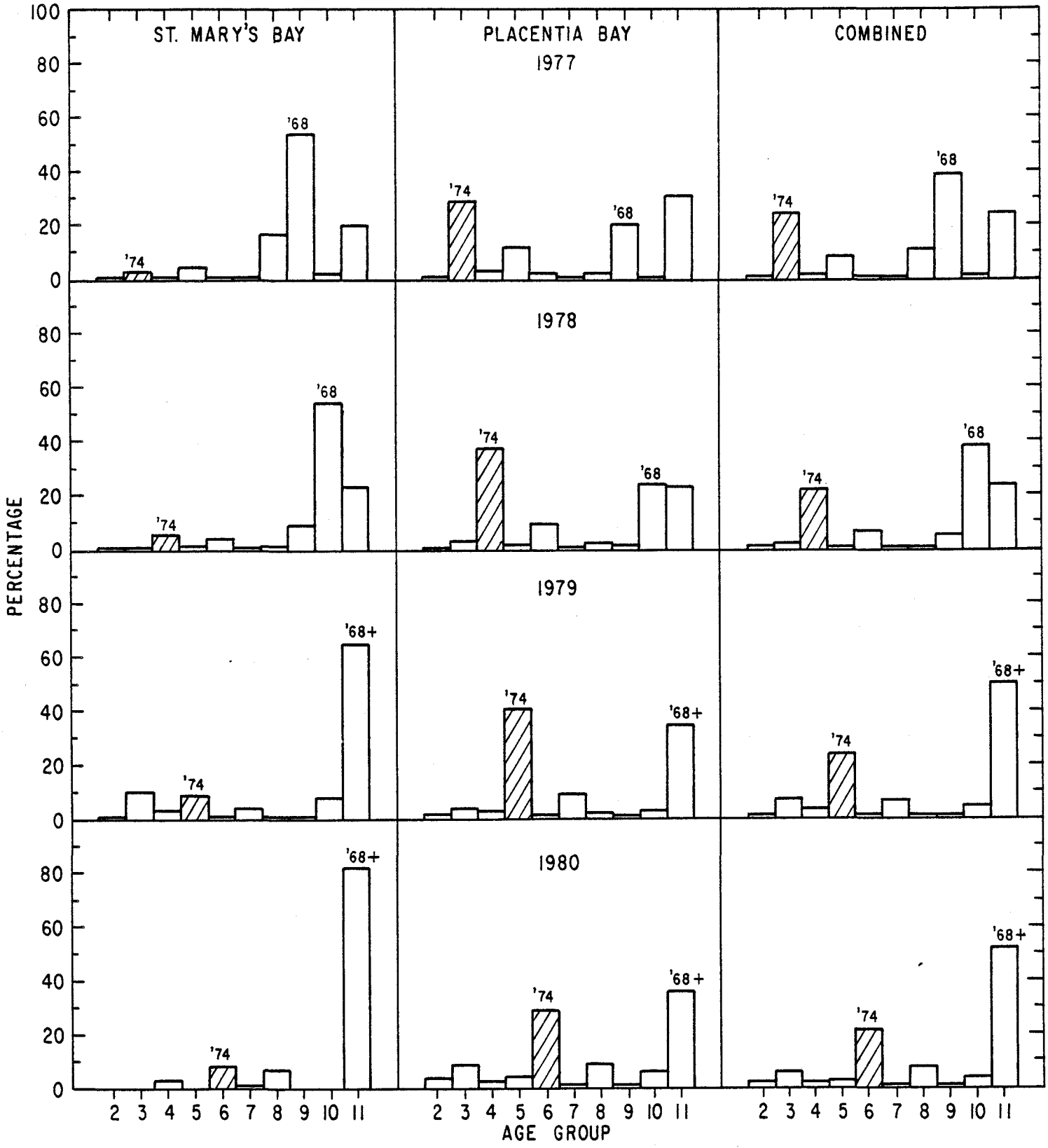

Fig. 2. Age frequency distribution for St. Mary's-Placentia spring-spawning herring for 1977-80.