Canadian Atlantic Fisheries
Scientific Advisory Committee

CAFSAC
Research Document # 82/37

East Coast Newfoundland Herring
Same old story: stocks in decline!

by

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

Abstract

This paper provides a continuation of the annual assessments of the four east coast Newfoundland herring stock complexes: (1) White Bay - Notre Dame Bay, (2) Bonavista Bay, (3) Trinity Bay, and (4) Conception Bay - Southern Shore. Information collected in 1981 showed that recruitment continued to be poor and that the 1968 year-class continued to support the fishery. Landings decreased from 12,400 t in 1980 to 9,200 t in 1981 due to a lower TAC. Four sources of catch rate data were available: (1) ringnet purchase slips, (2) ringnet log records, (3) gillnet purchase slips and (4) research gillnet program. Details are given on the purpose, organization and effectiveness of this research program. The gillnet information was considered the most reliable and was used in the calculation of total mortality coefficients ($\bar{Z}$). Estimates of terminal fishing mortality (F_t) were derived from trial runs of cohort analysis for each of the $\bar{Z}$'s calculated. Management considerations are provided for 1982 and 1983.

Résumé

Le présent article continue la série d'évaluations annuelles des quatre complexes de stocks de harengs de la côte est de Terre-Neuve: (1) baie Blanche - baie Notre-Dame, (2) baie Bonavista, (3) baie de la Trinité et (4) baie de la Conception côte sud. Les données recueillies en 1981 démontrent que le recrutement continue d'être faible et que la classe d'âge de 1968 est encore celle qui supporte cette pêche. Le TPA ayant été réduit, les débarquements ont diminué, passant de 12 400 t en 1980 à 9 200 t en 1981. On dispose de quatre sources de données sur les taux de capture: (1) les fiches de débarquements des bateaux pêchant à la bolinche, (2) les journaux de bord de ces bateaux, (3) les fiches de débarquements des bateaux pêchant aux filets maillants et (4) le programme de recherche avec filets maillants. Nous donnons le détail des objectifs, de l'organisation et de l'efficacité de ce programme. Nous considérons les données des filets maillants comme étant les plus fiables et nous les utilisons dans le calcul des coefficients de mortalité totale (Z). Des passages d'essai d'analyse des cohortes ont servi à estimer la mortalité par pêche de dernière année (F_t) pour chacun des Z calculés. En dernier lieu, nous discutons de mesures de gestion pour 1982 et 1983.

Introduction

The east coast Newfoundland herring fishery exploits four recognized stock complexes: 1) White Bay - Notre Dame Bay, 2) Bonavista Bay, 3) Trinity Bay, and 4) Conception Bay - Southern Shore. This fishery has depended entirely upon the very strong 1968 year-class for the past ten years. Data suggest this trend continued in 1981. This document follows closely the format of the last two year's assessments (Wheeler and Winters 1980, 1981) summarizing the results of data collected from the 1981 commercial fishery and suggesting management considerations for 1982 and 1983.

It also documents preliminary results of a long-term research program initiated along the east coast of Newfoundland in the fall of 1980 to obtain catch rates independent of the commercial fishery. Fixed gear fishermen were chosen from selected communities on the basis of their past performance in the herring fishery. The communities were chosen from three of the four stock areas; the Conception Bay - Southern Shore stock complex was excluded due to inconsistent fall fishing effort in the area. The fishermen were contracted to fish a fleet of five experimental gillnets (mesh sizes 50.8, 57.5, 63.5, 69.9 and 76.2 mm) for a period of one month each year, October or November depending upon the area, hauling the nets once a day during that period. Each fisherman was provided with a detailed log book and was required to record the date and time the gear was hauled, the total number of herring caught, and the number of herring caught by mesh size. They were also required to collect three samples per week, fifty-five herring per sample, twelve samples for the duration of the contract, collected from each net in proportion to the numbers caught by that mesh size. Six fisherman were contracted in 1980; an additional three were contracted in 1981 to expand the coverage area.

Recent catch statistics

Prior to 1970, annual landings along the east coast of Newfoundland were historically low, less than 10,000 t. Landings increased through the 1970's with the recruitment of the strong 1968 year-class and the development of a ringnet fleet. Landings in 1981 (Table 1) declined to 9,200 t from a high of 26,363 t in 1979. The 9,200 t catch represented a 31% overrun of the 7,000 t TAC. This was due to management's decision to allow an additional 3,500 t to be taken during the 1981 fall fishery. Similar to the preceding two years, inshore gears (primarily gillnets) accounted for 70% of the catch. TAC's were first advised for these stocks in 1977; both TAC's and catches ('000 t) are listed below for all stock areas:

	1977	1978	1979	1980	1981
TAC	22.0	17.4	20.8	9.8	7.0
Catch	25.7	23.4	26.4	12.4	9.2

Age composition

Except for area A and B, where the 1976 year-class represented 15% of the catch, the 1968 and 1969 year-classes continued to sustain the fishery (Fig. 1).

Spring spawners continued to dominate the catch in all areas. However, in the more southern stock complexes, where stock sizes are smaller, autumn-spawners represented a greater percentage of the catch.

	Area			
	A&B	C	D	E&F
% Spring Spawners	98	95	90	88

Assessment Parameters

1) Age specific weights

Average weights-at-age (Table 2), derived from biological samples taken in the first two quarters of the year from each stock area, were changed from those used in last year's assessment to reflect increased weight-at-age, especially of the dominant 11+ age groups.

2) Partial recruitment rates

Since recruitment of the younger age groups is low, partial recruitment rates (Table 3) used in initiating cohort analysis were not changed from those used in the previous stock assessment (Wheeler and Winters 1981).

3) CPUE analysis

The same three sources of catch rate data, 1) ringnet purchase slips, 2) ringnet log records, and 3) commercial gillnet purchase slips, as used last year, were again utilized this year. In addition, the fall research gillnet program provided catch rate information for three of the four stock areas.

Catch rates derived from ringnet purchase slips have been found to be unreliable as they do not account for searching time or cooperation between vessels. The data for 1981 (Table 4) show increases in catch per operating day in two of the three areas. Data were combined for all vessels, since all vessels had at least four year's fishing experience. The increased catch rates probably more truly represent increased efficiency and cooperation between vessels, rather than an increase in stock abundance.

Similarly, catch rates derived from ringnet log records (Table 5) show increases in catch per set operating day in two of the three stock areas. Log books were introduced to the ringnet fleet in 1979; cooperation has not been good and each year has seen a reduced number of returns. Consequently, this data base is relatively small and although it allows a measure of searching time, it does not indicate when vessels are teaming up in search of herring.

The gillnet purchase slip catch rate data base is expanding each year as gillnets represent an ever increasing portion of the catch. Last year, changes in the amount of gear used were accounted for by standardizing catches and then calculating catch per landing. This year, after contacting each of the fishermen used in the yearly comparisons, values of catch per net per landing were calculated. Only those fishermen who had consistently fished the same

area and season for the past three to five years were used in the analysis. The following number of fishermen were used per area: A&B-23, C-8, D-6, and E&F-5. Catch rates (Table 6) declined in the two more southern stock complexes (Areas D and E&F), remained relatively stable in Area C, and increased in Area A&B. The increase in Area A&B is most difficult to explain and leads to problems in calculating a terminal fishing mortality. As was the case last year, it is felt that the gillnets represent the most reliable source of catch rate data.

Although the fall research gillnet program has been underway only two years and represents a relatively small sample size, its catch rate information should be reliable as it represents a fixed unit of effort from year to year. Data from the program (Table 7) show decreased catch rates in the three stock areas sampled.

4) Calculation of total mortality ($\hat{Z}$)

The linear formula of Paloheimo (1961) was used to calculate total mortality coefficients ($\hat{Z}$) for age groups (5+) for 1980-81 based upon the ringnet catch rates (Tables 4 and 5). Effort values (f) were calculated from fall ringnet landings and fall ringnet CPUE. Only two of the $\hat{Z}$'s calculated were positive values and both were extremely low (<0.15).

In calculating mortality coefficients ($\hat{Z}$) from the gillnet catch rate data (Table 6), the effort values (f) were adjusted to account for gillnet selectivity. Olsen (1959) calculated selectivity curves for Newfoundland herring based upon three different mesh size nets. Selectivity values by length interval (Table 8) were determined for a 65 mm mesh net, the standard commercial size net used in the east coast Newfoundland fishery. These selectivity values were then applied to age-length keys generated from biological samples collected from gillnets from each area during the specific seasons from 1977 to 1981. An example is given in Table 8. The selectivity values adjusted the frequencies to account for those fish not captured by the gear and thus allowed the calculation of partial recruitment values for each age. A summary of these partial recruitment values is given in Table 9. These values were then applied to the gillnet catch matrix for the appropriate season each year to adjust the landings for gillnet selectivity. The most important aspect of this correction factor occurs in the older age groups (11+) where the standard commercial gillnet is not as effective. This is especially important along the east coast where so many of the herring are in these age classes. Effort values (Table 6) were calculated from appropriate corrected seasonal gillnet landings and gillnet CPUE. Mortality coefficients ($\hat{Z}$) were calculated for each area for 1977-78, 1978-79, 1979-80, 1980-81 and 1979-81. The values of $\hat{Z}$ 80-81 for Areas D and E&F, where catch rates decreased from 1980 to 1981 appear realistic. For areas A&B and C, where catch rates increased or remained stable, the values of $\hat{Z}$ 80-81 were either very low or negative. A two year average $\hat{Z}$ (79-81) was calculated to see if any trend existed over a longer period. With one exception, the values of $\hat{Z}$79-81 were relatively low (<.40).

Total mortality estimates were more readily calculated from the research gillnet data since estimates of effort were not required. In all three stock areas, the calculated values of $\hat{Z}$ (Table 7) were extremely high (>1.00).

Trial runs of cohort analysis were made to obtain the best estimates of terminal fishing mortality (F_t) for each of the $\bar{z}$'s calculated. These data are summarized in Table 10. In trying to choose the best estimates of F_t two trends become obvious. The commercial gillnet data tend to give low estimates of F_t and the research gillnet data give high estimates of F_t. Most of the values derived from ringnet data were negative and those that were not were deemed unreliable primarily due to the degree of cooperation exercised by the ringnet fleet which cannot be determined from their catch rates.

Results of the Assessment

It was not possible to accurately define the fishing mortality for 1981 from the available CPUE data. The reasons for this are unclear. The steady catch rate in Area C and the increasing rate in Area A&B do not appear to be due to an increase in stock abundance. They may be more related to the nature of the fishery in 1981 which was constricted in the spring to a shorter time period and occurred at a time of peak abundance. In Areas D and E&F, where stock abundance is lower, this shorter season did not affect catch rates. However, for all estimates of F_t considered, stock sizes were extremely low, less than 10% of maximum levels observed during the 1970's.

Projections based upon last year's assessment (Wheeler and Winters 1981) indicated that the abundance of all these stocks (2+ biomass) would continue to decline in the early 1980's even in the absence of fishing, if poor recruitment continues. Data collected within the past year suggests continued poor recruitment to these stocks. Advice provided by CAFSAC last year recommended that from the biological point of view the fishery should be closed in 1982. Since a TAC of 2000 t has already been allocated for 1982, it is impossible to follow through with last year's recommendation. However, this TAC should not be overrun and the advice of closure should again be made for 1983.

References cited

Olsen, S. 1959. Mesh selection in herring gillnets. J. Fish. Res. Board Can. 16: 339-349.

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

Wheeler, J. P., and G. H. Winters. 1980. Analysis of stock size and yield of east coast Newfoundland herring stocks. CAFSAC Res. Doc. 80/52, 46 p.

Wheeler, J. P., and G. H. Winters. 1981. An assessment of the east coast Newfoundland herring stocks. CAFSAC Res. Doc. 81/42, 60 p.

Table 1. East Coast herring landings (t) by area and gear, 1973-81

Year	Gear	A	B	C	D	E&F	Total
1973	Inshore	816	1,658	504	544	1,098	4,620
	Ringnet	-	-	-	-	-	-
	Purse seine	1	1	5	156	211	374
	TOTAL	817	1,659	509	700	1,309	4,994
1974	Inshore	1,423	2,588	642	1,223	536	6,412
	Ringnet	8	6	-	428	2,107	2,549
	Purse seine	-	-	-	-	48	48
	TOTAL	1,431	2,594	642	1,651	2,691	9,009
1975	Inshore	1,584	1,852	450	743	893	5,522
	Ringnet	-	108	-	1,790	2,596	4,494
	Purse seine	828	1,183	1,559	1,370	13	4,953
	TOTAL	2,412	3,143	2,009	3,903	3,502	14,969
1976	Inshore	773	3,184	491	914	737	6,099
	Ringnet	487	3,412	3,052	1,054	1,748	9,753
	Purse seine	1,724	2,908	2,812	1,614	-	9,058
	TOTAL	2,984	9,504	6,355	3,582	2,485	24,910
1977	Inshore	552	4,893	2,808	1,145	461	9,859
	Ringnet	1,227	4,922	6,204	1,548	1,716	15,617
	Pair trawl	-	-	236	-	-	236
	TOTAL	1,779	9,815	9,248	2,693	2,177	25,712
1978	Inshore	1,704	6,476	1,473	1,282	714	11,649
	Ringnet	1,254	3,980	4,239	1,055	1,231	11,759
	TOTAL	2,958	10,456	5,712	2,337	1,945	23,408
1979	Inshore	1,051	11,843	2,755	2,350	451	18,450
	Ringnet	832	1,968	3,490	1,181	442	7,913
	TOTAL	1,883	13,811	6,245	3,531	893	26,363
1980	Inshore	1,352	3,518	1,973	754	158	7,755
	Ringnet	747	913	1,714	964	319	4,657
	TOTAL	2,099	4,431	3,687	1,718	477	12,412
1981	Inshore	686	2,740	2,219	748	225	6,618
	Ringnet	219	1,130	1,149	123	-	2,621
	TOTAL	905	3,870	3,368	871	225	9,239

1981 figures are provisional.

Table 2. Average weight-at-age (cm) of Newfoundland East Coast herring in 1981.

	Area			
Age	A&B	C	D	E&F
2	90	60	90	95
3	138	149	182	126
4	197	242	248	250
5	233	270	314	280
6	264	300	340	310
7	290	305	345	325
8	300	310	365	330
9	305	334	370	337
10	306	341	375	350
11	345	352	378	380

Table 3. Age specific selectivity patterns for each defined stock, used to initiate cohort analysis.

	Area			
Age	A&B	C	D	E&F
2	0.10	0.15	0.15	0.30
3	0.35	0.40	0.25	0.45
4	0.55	0.70	0.40	0.60
5	1.00	1.00	0.65	0.80
6	1.00	1.00	1.00	1.00
7	1.00	1.00	1.00	1.00
8	1.00	1.00	1.00	1.00
9	1.00	1.00	1.00	1.00
10	1.00	1.00	1.00	1.00
11	1.00	1.00	1.00	1.00

Table 4. Calculation of instantaneous total mortality rates ($\bar{Z}$), for fall fishery months combined (September-December), from catch per unit effort indices for ringnet vessels (purchase slip data).

Area	Catch/operating day (t)				f				Z
	1978	1979	1980	1981	1978	1979	1980	1981	80-81
A&B	19.3	21.7	15.4	12.6	92	59	62	104	0.11
C	14.3	11.7	10.5	11.6	187	156	109	98	-0.03
D	16.1	22.0	7.5	16.5	18	23	73	7	-0.80

Table 5. Calculation of instantaneous total mortality (Z), by month, from catch per unit effort indices of ringnet vessels (from log records).

Area	Month	Catch/set operating day (t)			f			Z
		1979	1980	1981	1979	1980	1981	80-81
A&B	October	4.5	8.7	12.2	285	107	108	-0.39
C	October	20	3.5	5.6	913	327	204	-0.40
D	November	-	5.8	5.2	-	82	19	0.08

Table 6. Calculation of instantaneous total mortality ($\bar{Z}$), by season, from catch per unit effort indices of gillnet fishermen who have fished the past 3-5 yr, 1977-78.

		Catch/net/landing (kg)					f					$\bar{Z}$	$\bar{Z}$	$\bar{Z}$	$\bar{Z}$	$\bar{Z}$
		1977	1978	1979	1980	1981	1977	1978	1979	1980	1981	77-78	78-79	79-80	80-81	79-81
A&B	Spring	68.5	50.8	67.6	31.8	54.4	20,732	90,121	99,015	77,031	35,481	0.39	-0.25	0.80	-0.51	0.15
C	Spring	104.3	44.5	111.6	68.5	57.2	1,272	21,641	10,249	11,787	12,081	0.81	-0.87	0.66	0.06	0.36
	Fall	209.6	65.3	47.6	32.2	34.9	824	5,011	24,347	13,324	22,991	0.84	0.80	0.43	-0.17	0.13
	Combined	183.3	63.1	63.5	39.5	39.5	1,666	20,449	36,269	31,331	37,754	0.96	0.19	0.58	-0.11	0.24
D	Spring	-	-	235.9	63.1	39.5	-	-	2,653	5,128	8,600	-	-	1.33	0.47	0.90
E&F	Spring	69.9	51.7	30.4	28.1	16.3	2,500	7,372	7,552	3,726	12,821	0.35	0.61	-0.07	0.62	0.28

Table 7. Comparison of catch rates (total number of herring caught per day) and calculation of instantaneous total mortality rates for 1980-81 from East Coast Newfoundland Fall Research Program.

Area	Community	Catch rates 1980	Catch rates 1981	Z 80-81
A&B	Westport	40.8	28.7	0.35
	La Scie	241.0	167.0	0.37
	Harrys Harbour	-	83.3	-
	Leading Tickles	-	141.1	-
	Hillgrade	672.9	88.7	2.03
	Average*	318.2	94.8	1.21
C	Centreville	19.4	27.6	-0.35
	Salvage	131.9	6.6	3.00
	Portland	-	247.5	-
	Average*	75.7	17.1	1.49
D	Hickman's Harbour	51.1	2.7	2.94
	Average*	51.1	2.7	2.94

* excluding additional communities in 1981.

Table 8. Selectivity factors for 65 mm mesh gillnets, as derived from Olson (1959), and their effects when applied to an age-length frequency from biological samples collected in 1979 from the commercial gillnet fishery in Area A&B.

Length (cm)	Selectivity factor	2	3	4	5	6	7	8	9	10	11+
30	0.70				8 (11.4)						
31	0.85			1 (1.2)	19 (22.4)	1 (1.2)					
32	0.96				54 (56.3)		2 (2.1)	4 (4.2)	10 (10.4)	11 (11.5)	1 (1.0)
33	1.00				43 (43.0)	8 (8.0)	16 (16.0)	10 (10.0	35 (35.0)	140 (140.0)	39 (39.0)
34	0.97				11 (11.3)		15 (15.5)	9 (9.3)	32 (33.0)	298 (307.2)	244 (251.6)
35	0.87				1 (1.2)		3 (3.5)	1 (1.2)	2 (2.3)	28 (32.2)	394 (452.9)
36	0.73					1 (1.4)	1 (1.4)				140 (191.8)
37	0.56										37 (66.1)
38	0.41										10 (24.4)
39	0.34										2 (5.9)
40	0.27										1 (3.7)
Frequency		-	-	1	136	10	37	24	79	477	868
Adjusted frequency		-	-	1.2	145.6	10.6	38.5	24.7	80.7	490.9	1036.4
Partial Recruitment [1]		-	-	0.85	0.93	0.94	0.96	0.97	0.98	0.97	0.84

Table 9. Partial recruitment values, by area, season, and year, for commercial gillnet catches, derived from applying gillnet selectivity factors to age-length frequencies of biological samples collected from the appropriate commercial gillnet fisheries.

Area	Season	Year	2	3	4	5	6	7	8	9	10	11+
A&B	Spring	1977	-	-	-	0.91	1.00	0.98	0.98	0.97	0.99	0.81
		1978	-	-	0.81	0.88	0.96	0.96	1.00	0.96	0.77	0.91
		1979	-	-	0.85	0.93	0.94	0.96	0.97	0.98	0.97	0.84
		1980	-	-	0.54	0.96	0.97	-	0.94	0.93	0.95	0.84
		1981	-	-	0.85	0.82	0.97	0.97	0.87	0.91	0.94	0.78
C	Spring	1977	-	-	0.70	0.91	0.94	0.91	0.97	0.98	0.97	0.73
		1978	-	-	-	-	1.00	1.00	0.98	0.98	0.95	0.79
		1979	-	-	-	0.93	-	0.98	-	0.98	0.96	0.82
		1980	-	-	-	-	-	-	1.00	1.00	0.91	0.81
		1981	-	-	-	0.94	-	0.96	-	0.88	0.93	0.79
	Fall	1979	-	-	-	-	-	0.83	-	-	1.00	0.79
		1980	-	-	-	-	-	-	-	-	1.00	0.80
D	Spring	1977	-	-	-	-	-	-	0.98	0.98	-	0.75
		1978	-	-	-	-	0.97	-	1.00	0.99	0.94	0.73
		1979	-	-	-	0.96	1.00	0.97	0.87	0.99	0.97	0.82
		1980	-	-	-	1.00	0.86	-	0.83	-	0.96	0.79
		1981	-	0.36	-	0.95	0.95	0.71	-	0.77	0.91	0.76
E&F	Spring	1977	-	-	-	0.97	-	1.00	0.98	0.97	0.91	0.72
		1978	-	-	0.87	0.95	0.96	0.91	1.00	0.90	0.89	0.67
		1979	-	-	-	0.97	0.91	0.91	-	-	0.96	0.79
		1980	-	-	-	-	0.91	-	0.83	-	0.95	0.69

Table 10. Summary of total mortality coefficient values ($\bar{z}$) and resultant estimates of terminal fishing mortality (F_t) calculated from the various sources of catch rate data.

Area	$\bar{z}$	F_t	Catch rate source
A&B	-0.51	-	Commercial spring gillnet fishery ($\bar{z}$ 80-81)
	-0.39	-	October ringnet fishery (from log records)
	0.15	-	Commercial spring gillnet fishery ($\bar{z}$ 79-81)
	0.11	-	Fall ringnet fishery (from purchase slips)
	1.21	1.04	Fall research gillnet program
C	-0.40	-	October ringnet fishery (from log records)
	-0.03	-	Fall ringnet fishery (from purchase slips)
	-0.17	-	Commercial fall gillnet fishery ($\bar{z}$ 80-81)
	-0.11	-	Commercial spring and fall gillnet fishery ($\bar{z}$ 80-81)
	0.06	-	Commercial spring gillnet fishery ($\bar{z}$ 80-81)
	0.13	-	Commercial fall gillnet fishery ($\bar{z}$ 79-81)
	0.24	0.06	Commercial spring and fall gillnet fishery ($\bar{z}$ 79-81)
	0.36	0.19	Commercial spring gillnet fishery ($\bar{z}$ 79-81)
	1.49	1.31	Fall research gillnet program
D	-0.80	-	Fall ringnet fishery (from purchase slips)
	0.08	-	November ringnet fishery (from log records)
	0.40	0.27	Commercial spring gillnet fishery ($\bar{z}$ 80-81)
	0.90	0.70	Commercial spring gillnet fishery ($\bar{z}$ 79-81)
	2.94	-	Fall research gillnet program
E&F	0.62	0.43	Commercial spring gillnet fishery ($\bar{z}$ 80-81)
	0.28	0.09	Commercial spring gillnet fishery ($\bar{z}$ 79-81)

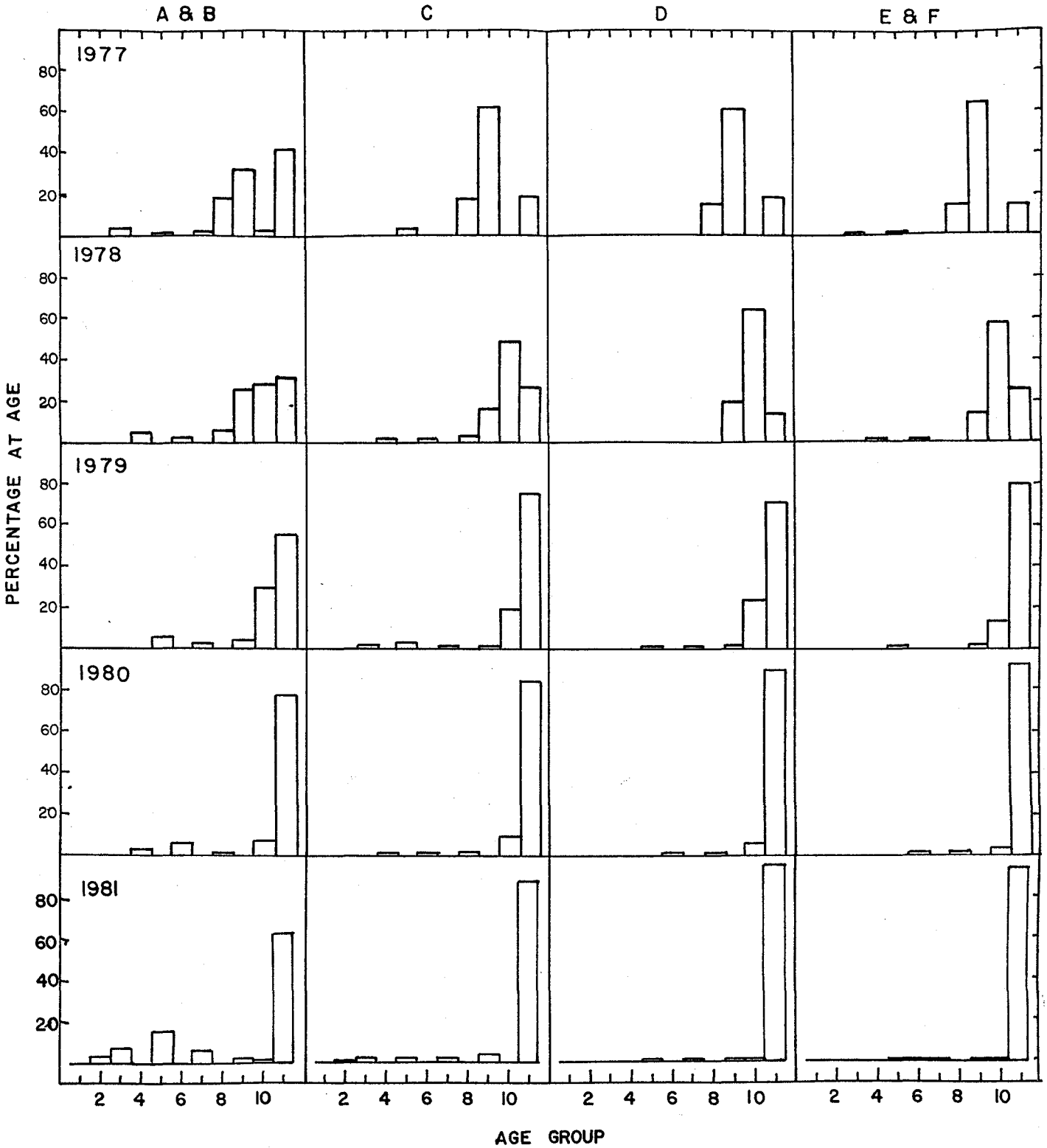

Fig. 1. Age distribution of herring in the landings from east coast Newfoundland herring stocks, 1977-81.