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Assessment of yield potential of eastern Newfoundland herring stocks

by

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Introduction

Herring fisheries along eastern Newfoundland have never until recently contributed significantly to commercial fish landings in Newfoundland, not even during the late 1940's when total landings of herring from Newfoundland waters soared to 85,000 m tons in response to requests from UNRA for herring as food for war-torn Europe. East coast herring landings peaked at 7000 m tons during this period, a level substantially below potential yields; landings dropped to between 1000-2000 m tons in the 1950's and '60's with most of the landings being utilized as lobster bait and dog food.

During the early 1970's, however, east coast herring stocks began to attract interest due to three main factors (a) increasing demand for food herring due mainly to a decline in Northeast Atlantic herring stocks (b) diminishing stocks of herring along the Atlantic Seaboard and Gulf of St. Lawrence (c) and quota regulations, both national and international, leaving only eastern Newfoundland and northwest Newfoundland as relatively unexploited, unregulated areas. Concurrent with and in part resulting from this increased interest in east coast herring was the introduction and development of new fishing techniques by the Industrial Development Branch of the Fisheries and Marine Service. These new fishing techniques (ring-nets, pair trawling) were designed to transform a relatively inflexible fleet of traditional groundfish long-liners into flexible multi-species fishing units capable of off-setting reductions in abundance of commercial groundfish species, particularly cod and flounder. In 1975 a further development of east coast herring fisheries occurred when 3 commercial purse-seiners fishing under special (exploratory-research) permits provided catch data suggesting substantial quantities of herring in nearly all the eastern Newfoundland bays.

As a result of the above developments and to provide for rational exploitation of the stocks, catch quotas totalling 27,000 m tons were imposed in 1976 on the basis of preliminary analyses of data accumulated by the St. John's Biological Station since the late 1960's. This document summarizes those analyses as well as interprets new data derived from the 1976 fishery.

Recent catch statistics

Catch statistics are reported by statistical areas (defined in alphabetical manner in Fig. 1) which essentially correspond with the 5 east coast bays. Landings (see table below) increased from less than 700 m tons in 1969 to over 9000 m tons in 1974 and to nearly 25,000 m tons in 1976. Such increases in landings have occurred in all bays but have been particularly evident since 1972 in Trinity and Conception Bays due to the introduction of ring-netting which has since spread to all areas. Traditional inshore gears (gill-nets, bar-seines, trap) accounted for about 61,000 m tons in 1976, an increase from 52,000 m tons in 1975 (Table 1, and ring-nets increased from 4200 m tons in 1975 to nearly 9800 m tons in 1976.

Catch (m tons)

Year	W. Bay (A)	N.D. Bay (B)	B. Bay (C)	T. Bay (D)	Con. Bay (E + F)	Total
1969	25	341	109	176	30	681
1970	49	475	147	484	151	1306
1971	204	3454	213	892	185	4948
1972	828	996	247	342	582	2995
1973	785	1657	497	739	1308	4986
1974	1442	2592	642	1651	2716	9043
1975	2412	3143	2009	3903	3539	15,006
1976	2984	9504	6355	3582	2485	24,910

Biological characteristics

(a) Age compositions

Age compositions of commercial catches of herring in the various east coast bays are shown in Fig. 2. The 1963 year-class was dominant in all areas up to 1971 but has been replaced by the very strong 1968 year-class since then. East coast fisheries have typically exploited mature herring and thus young fish (≤ 4 years old) do not show very strongly in catches. The 1969 year-class has also been dominant in the northern bays but tends to become progressively weaker in relation to the 1958 year-class in the southern bays. Also of particular interest is that the 2 northern bays still have significant numbers of old fish remaining in the population and thus have a more stable population age-structure than for example in Trinity and Conception Bay herring which are largely (60%) supported by one year-class (1968).

(b) Growth rates

Mean weights-at-age (quarters 1-3 combined, 1973-75) and stable population biomass (1000 recruits at age 2) of east coast herring are compared with southeastern Newfoundland herring stocks in the table below.

Weight-at-age (kg) by Area

Age	White Bay	N.D. Bay	Bon. Bay	Trinity Bay	Con. Bay	St. Mary's Bay	Fortune Bay
2	.070	.070	.080	.080	.080	.080	.080
3	.122	.126	.125	.141	.139	.161	.154
4	.182	.188	.187	.211	.207	.203	.207
5	.208	.198	.212	.218	.220	.234	.232
6	.222	.220	.236	.240	.241	.241	.276
7	.248	.230	.254	.255	.255	.272	.296
8	.267	.248	.273	.272	.271	.285	.310
9	.280	.262	.298	.294	.278	.305	.331
10	.288	.271	.299	.313	.291	.320	.350
11+	.343	.300	.343	.343	.325	.353	.375
Biomass prod. per 1000 recruits (Kg)	862	837	896	934	921	971	1015

There is a general increase in weight-at-age from White Bay south to Fortune Bay and this is particularly so in the younger age-groups (≤ 5 years). This increase in growth is of course reflected in the biomass production; White Bay for example being only 85% of the level of Fortune Bay herring for the same number of recruits. Such changes in growth are also evident in other fish stocks such as cod, capelin etc., and probably reflect the increasing effect of the cold inshore component of the Labrador current in the northern bays of eastern Newfoundland.

(c) Spawning-group composition

Since 1966 yearly reports of herring spawning in eastern Newfoundland have been obtained from Fisheries and Marine field personnel and this information combined with data from biological sampling reveal that eastern Newfoundland herring are primarily spring-spawners which spawn in shallow water in May and June. There is, however, a small component of large Labrador-type herring in all of the eastern bays and these spawn in fairly deep water (30-40 fath) in August-September. The relative proportion of spring versus fall-spawners in commercial herring catches since 1969 is shown in the table below.

% Spring-spawners by area

Year	A	B	C	D	E + F	Average (%)
1969	73	93	62	98	91	83
1970	82	84	69	65	73	75
1971	73	99	90	92	91	89
1972	93	78	99	99	100	94
1973	97	96	96	99	98	97
1974	98	96	(34)	99	99	98
1975	96	99	96	99	97	97
1976	96	99	97	99	99	98

There has been a decrease in the relative contribution of fall-spawners to herring catches along eastern Newfoundland since sampling began in 1969; since 1973 over 95% of the catches are comprised of spring-spawners. This decrease is probably due mostly to an increase in abundance of spring-spawners as a result of the recruitment of the strong 1968 year-class but it may also reflect a decline in abundance of fall-spawners which are predominantly very old (11 years old and older) fish.

(d) Stock migrations and interrelationships

Differences in growth rates, age compositions and the regular appearance of herring in traditional spawning areas in each bay suggest that to a large extent each bay along eastern Newfoundland has its own resident population of herring. Tagging studies however, have shown some degree of movement between bays, mainly as a northward feeding migration in summer and a southward wintering migration in the fall (Table 2). This pattern of migration results in substantial intermix between White Bay and Notre Dame Bay herring and also between herring from Conception Bay and the southern Avalon. For the purpose of stock assessment therefore these areas are combined as unit stocks and it is assumed that the other bays (Trinity and Bonavista) have resident populations which intermingle with adjacent bays but only to an incidental degree.

Estimation of stock size and yield

Method A

Catch-per-unit-effort (CPUE) and effort data (in units of purse-seiner operating days) are available for 1975 and 1976 for areas A, B, C and D. No such data are available for areas E and F. A summary of the catch/effort data is given in Table 3. The data indicate very little change in abundance indices from 1975 to 1976 although biomass must have declined since the same year-classes (mainly 1968, 1969) were exploited in both years. This suggests that learning factors are involved as indeed might be expected since 1975 was the first year that purse-seiners fished along eastern Newfoundland and little was known of the distribution of herring in the various bays in late fall. In 1976 however the purse-seine fleet moved directly to the areas previously fished in 1975 resulting in immediate catching success. A similar situation occurred in Fortune Bay in 1967 when purse-seiners began exploiting herring in that area. Regression analyses (CPUE versus biomass) indicated that the CPUE when adjusted for learning was 1.53 times greater than the observed CPUE for 1967 (data on file). It is assumed that a similar learning factor applied to the purse-seine effort along eastern Newfoundland in 1975 and the adjusted effort data have been used to compute total instantaneous mortalities (Z) (5^+) by the Paloheimo method. The results are summarized below:

	Effort (days)		Z (1975-76)	F 1976
Area	1975	1976		
A + B	40.7	134.7	0.43	.25
C	11.8	55.4	0.37	.20
D	29.4	38.8	0.48	.30

Since the above data is an estimate of change in abundance indices from late fall 1975 to late fall 1976 the Z values thus obtained may therefore be considered as approximate estimates of Z in 1976. Assuming M = 0.2 this suggests value of F for 1976 as indicated in the above table. General observations of the fishery in Conception Bay in 1976 suggest effort levels equivalent to those in 1975 which, from general observations, were probably equivalent to those in Trinity Bay. A level of F = 0.25 has therefore been selected for Conception Bay in 1976; cohort analyses for all stocks are shown in Appendix I.

Adult (5^+) biomass levels (as estimated from cohort analyses) of east coast herring stocks increased from 73,000 m tons in 1969 to 171,000 m tons in 1974, declining to 112,000 m tons in 1976, mainly due to poor recruitment resulting from the 1970-73 year-classes. The 1974 year-class has been showing up in significant numbers in the 1977 fisheries along southeastern Newfoundland and also appear to be fairly strong in the Gulf of St. Lawrence spring-spawners. Recruitment strengths of the 1963-73 year-classes are summarized below:

Year-Class	Strength at age 2 (millions of fish)				Total
	A+B	C	D	E+F	
1963	230	85	55	44	414
1964	83	7	4	3	97
1965	56	22	21	7	106
1966	90	21	8	10	129
1967	37	18	8	3	66
1968	315	274	163	141	893
1969	161	59	22	37	279
1970	11	2	1	1	15
1971	4	2	1	1	8
1972	17	11	5	3	36
1973	3	9	1	2	15

Method B

The St. Mary's-Placentia and Fortune Bays herring stocks are fully exploited and reliable estimates of biomass levels are available for the period 1967-75. These stocks peaked in the late 1960's at a level of biomass around 120,000 m tons. Since herring are planktonic feeders their biomass production is likely to be closely related to primary (planktonic) production which occurs mainly in depths shallower than 100 fath. The surface area inside 100 fath in St. Mary's, Placentia and Fortune Bays is computed to be 2260 sq. miles; this implies a maximum biomass of 53 m tons per sq. mile (120,000/2260). Since east coast herring have slower growth rates their relative productivity should be correspondingly less; however no adjustments have been made to account for these differences since the woutheast Newfoundland stocks were already exploited in the late 1960's and hence biomass levels would have been higher in the unexploited state.

Parameters	Defined Stock			
	A+B	C	D	E+F
1. Surface area (sq. mi.) inside 100 fath contour (A)	2175	690	462	400
2. Max. Biomas (m tons) per unit area (B)	53	53	53	53
3. Estimated maximum biomass (A x B) (m tons)	115,000	36,600	24,500	21,200
4. Year of maximum biomass (from VPA)	1971	1972	1971	1971
5. Corresponding 1976 biomass (from VPA)	73,600	26,500	13,100	8000
6. Corresponding 1976 F (5^+)	.20	0.27	.35	.45

Estimates of biomass by this method are fairly close to estimates by Method A with the exception of Conception Bay for which Method A gives substantially higher values.

Calculation of optimum exploitation level

Yield-per-recruitment curves have been calculated for two options of partial recruitment relating to that observed recently (option A) and that which might be expected to occur with a strong year-class entering the fishery (option B). The results (Fig. 3) indicate $F_{0.1} = 0.55$ under option A and $F_{0.1} = 0.42$ under option B. These are relatively high levels of fishing mortality and would substantially reduce average biomass levels thereby maximizing fluctuations in catch. Accordingly a level of $F_{0.1} = 0.30$ has been selected as an appropriate exploitation level which would generate 80% of the maximum Y/R at a level of fishing effort less than 1/3 of that required for F_{max}.

Catch projections

Mean recruitment strengths and standard deviations have been calculated for the year-classes 1963-73 for each defined stock and (using a random number generator) a 20-year projection of catch at $F_{0.1} = 0.30$ has been computed, assuming that the 1974 year-class is equal to 1/2 the strength of the 1968 year-class. The results are shown in Fig. 4 and are given in detail for 1976-77 in Appendix II. A long-term average yield of 20,000 m tons is indicated for east coast herring with the major catches being derived from the three northern bays (Bonavista, Notre Dame and White Bay).

A summary of the 1977 projected catches at($F_{0.1} = 0.30$) by methods A and B is given below:

1977 Projected catch by area (m tons)

Method	A+B	C	D	E+F	Total
A	10,500	6,900	2,500	2,100	22,000
B	8,500	5,500	2,100	1,500	17,600
Av. long-term yield	8,000	5,500	4,000	2,500	20,000

Fisheries in areas A + B undoubtedly exploit a mixture of resident and migrating populations of herring and a partitioning of the TAC is recommended to prevent potential over-exploitation of local stocks of herring. Suggested areas are Cape Norman - Cape St. John, Cape St. John - North Head, North Head - Cape Freels.

Acknowledgements

Most of the technical staff of the Pelagic Section, Newfoundland Biological Station have been involved in the collection and preparation of data used in this report and their contributions are gratefully acknowledged. Dr. W.D. McKone kindly provided the tagging data described in this report.

Table 1. East coast herring catches (metric tons) by area and gear 1973-76.

Year	Gears	A	B	C	D	E&F
1973	Inshore	816	1658	504	544	1098
	Ring net	-	-	-	-	-
	Purse seine	1	1	5	156	211
1974	Inshore	1423	2588	642	1223	536
	Ring net	8	6	-	428	2107
	Purse seine	-	-	-	-	48
1975	Inshore	1584	1852	450	743	893
	Ring net	-	108	-	1790	2596
	Purse seine	828	1183	1559	1370	13
1976	Inshore	773	3184	491	914	737
	Ring net	487	3412	3052	1054	1748
	Purse seine	1724	2908	2812	1614	-

Table 2. Summary of recapture data (excluding returns from month of tagging) from tagging experiments along eastern Newfoundland, 1975-76.

Tagging locality	No. tagged	Tag recoveries by area							
		A	B	C	D	E	F	G	H
1975									
White Bay (A)	250	-	1	-	-	-	-	-	-
Notre Dame Bay (B)	6150	5	62	-	1	-	-	-	-
Bonavista Bay (C)	3750	-	1	19	2	-	-	-	-
Trinity Bay (D)	4025	-	-	5	82	1	-	-	1
Conception Bay (E)	5450	-	-	3	3	70	4	13	2
Southern Shore (F)	2000	-	-	1	-	17	27	24	-
1976									
White Bay	10,650	105	172	7	-	-	-	-	-
Notre Dame Bay	4911	5	50	1	-	-	-	-	-
Bonavista Bay	4125	-	1	181	1	-	-	-	1
Trinity Bay	5000	-	1	22	89	-	-	-	-
Conception Bay	4000	-	-	1	3	37	-	-	-
Southern Shore	4225	-	-	-	3	20	10	1	-
St. Mary's Bay	3825	-	-	1	1	3	3	333	2

Table 3. Purse seine catch-per-unit-effort data for various east coast bays 1975-76.

Area	CPUE (tons/day)	
	1975	1976
A & B	89.2	92.7
C	114.2	114.8
D	86.9	92.3

APP. I - Table 1

HERRING AREA A+B 1969-76 SS '000 AGES 2-18

NATURAL MORTALITY= 0.20

ASSUMED FISHING MORTALITY FOR LAST AGE = 0.25

ESTIMATED POPULATION FOR LAST YEAR

5. 5. 5. 5. 5. 5. 5. 1614.

PREDETERMINED FISHING MORTALITY USED FOR LAST YEAR

0.25000
0.25000
0.25000
0.25000
0.25000
0.25000
0.25000
0.25000
0.25000
0.25000
0.25000
0.25000
0.15000
0.06250
0.01250
0.00250

ESTIMATED POPULATIONS

AGE	1969	1970	1971	1972	1973	1974	1975	1976
2	36549.	315350.	161485.	11120.	3891.	16756.	3473.	53466.
3	74029.	29923.	258178.	132212.	9100.	3185.	13718.	2842.
4	37692.	60561.	24498.	211103.	107982.	6792.	2603.	11115.
5	46242.	30767.	49571.	20011.	170622.	87055.	5453.	1936.
6	103819.	37843.	25167.	40442.	16056.	137034.	68401.	4048.
7	9404.	84876.	30960.	20553.	33048.	12436.	107196.	51064.
8	3643.	7699.	68597.	24959.	16714.	26390.	9098.	81349.
9	14012.	2885.	6293.	46993.	20065.	13070.	20969.	6433.
10	14610.	11464.	2284.	4940.	37216.	16048.	9333.	16412.
11	10062.	11908.	9240.	1619.	3856.	28925.	12360.	6909.
12	28.	8201.	9599.	6535.	1265.	2997.	22278.	9150.
13	22.	22.	6610.	6790.	5101.	964.	2308.	16491.
14	17.	17.	17.	4670.	5301.	3965.	759.	1709.
15	13.	13.	13.	13.	3644.	4121.	3053.	561.
16	10.	10.	10.	10.	10.	2831.	3174.	2260.
17	7.	7.	7.	7.	7.	7.	2181.	2350.
18	5.	5.	5.	5.	5.	5.	5.	1614.
BIOMASS (5+)	46448	47310	50701	44387	71590	79308	67307	53823
F (5+)	<.01	.01	.08	.02	.03	.05	.09	.25

App. I - Table 2

HERRING AREA C 1969-76 SS '000 AGES 2-18

NATURAL MORTALITY= 0.20

ASSUMED FISHING MORTALITY FOR LAST AGE = 0.20

ESTIMATED POPULATION FOR LAST YEAR

6. 6. 6. 6. 6. 6. 6. 1116.

PREDETERMINED FISHING MORTALITY USED FOR LAST YEAR

0.20000
0.20000
0.20000
0.20000
0.20000
0.20000
0.20000
0.20000
0.20000
0.20000
0.20000
0.20000
0.12000
0.05000
0.01000
0.00200

ESTIMATED POPULATIONS

AGE	1969	1970	1971	1972	1973	1974	1975	1976
2	17708.	273679.	59076.	1526.	1960.	10594.	9074.	1657.
3	17184.	14497.	224068.	48367.	1248.	1604.	8673.	7428.
4	14472.	14069.	11668.	183355.	39590.	1020.	1312.	6781.
5	3713.	11848.	11517.	9555.	149776.	32396.	834.	1003.
6	38189.	3039.	9699.	9422.	7719.	121902.	26522.	595.
7	479.	31226.	2487.	7937.	7709.	6048.	99686.	20687.
8	7556.	391.	25371.	2007.	6460.	6301.	4908.	78355.
9	751.	6176.	320.	20451.	1604.	5217.	5134.	3895.
10	1935.	614.	4994.	261.	16460.	1239.	4193.	3765.
11	5366.	1575.	497.	4012.	210.	12934.	1001.	3221.
12	32.	4367.	1273.	400.	3227.	166.	10446.	770.
13	25.	25.	3533.	1021.	322.	2536.	134.	8044.
14	20.	20.	20.	2638.	821.	253.	2048.	103.
15	15.	15.	15.	15.	2283.	644.	205.	1577.
16	12.	12.	12.	12.	12.	1795.	520.	158.
17	9.	[illegible]	9.	9.	9.	9.	1450.	400.
18	6.	6.	6.	6.	6.	6.	6.	1116.
Biomass (5+)	14195	14643	14800	14969	40593	45312	40201	32755
F (5+)	<.01	<.01	.01	.01	.01	<.01	.05	.20

App. I - Table 3

HERRING AREA D 1969-76 SS 1000 AGES 2-18

NATURAL MORTALITY= 0.20

ASSUMED FISHING MORTALITY FOR LAST AGE = 0.30

ESTIMATED POPULATION FOR LAST YEAR

4. 4. 4. 4. 4. 4. 4. 25.

PREDETERMINED FISHING MORTALITY USED FOR LAST YEAR

0.30000
0.30000
0.30000
0.30000
0.30000
0.30000
0.30000
0.30000
0.30000
0.30000
0.30000
0.30000
0.18000
0.07500
0.01500
0.00300

ESTIMATED POPULATIONS

AGE	1969	1970	1971	1972	1973	1974	1975	1976
2	7621.	162730.	21686.	769.	314.	4496.	906.	4051.
3	6756.	6403.	133231.	17754.	645.	256.	3680.	741.
4	14118.	5526.	5241.	108801.	14535.	527.	209.	2974.
5	2434.	11556.	4515.	4148.	88195.	11848.	430.	120.
6	24697.	1965.	9452.	3684.	3229.	69646.	9488.	292.
7	441.	20004.	1573.	7726.	2938.	2571.	52754.	6454.
8	354.	357.	15787.	1136.	6296.	2359.	1749.	33445.
9	407.	266.	259.	12303.	689.	5154.	1818.	1144.
10	185.	311.	158.	96.	9917.	705.	4035.	1000.
11	900.	138.	193.	98.	69.	7978.	528.	2946.
12	26.	525.	104.	107.	69.	55.	5981.	373.
13	20.	20.	293.	78.	69.	55.	42.	4219.
14	16.	16.	16.	127.	61.	55.	42.	30.
15	12.	12.	12.	12.	61.	49.	42.	30.
16	9.	9.	9.	9.	9.	49.	37.	30.
17	6.	6.	6.	6.	6.	6.	37.	25.
18	4.	4.	4.	4.	4.	4.	4.	25.
BioMass (5+)	7000	8394	8114	7656	24344	24581	20315	14055
F (5+)	.02	.03	.04	.02	.03	.07	.23	.30

APP. I - Table 4

HERRING AREA E+F 1969-76 SS'000 AGES 2-11

NATURAL MORTALITY= 0.20

ASSUMED FISHING MORTALITY FOR LAST AGE = 0.25

ESTIMATED POPULATION FOR LAST YEAR

5. 5. 5. 5. 5. 5. 5. 84.

PREDETERMINED FISHING MORTALITY USED FOR LAST YEAR

0.25000
0.25000
0.25000
0.25000
0.25000
0.25000
0.25000
0.25000
0.25000
0.25000
0.25000
0.25000
0.15000
0.06250
0.01250
0.00250

ESTIMATED POPULATIONS

AGE	1969	1970	1971	1972	1973	1974	1975	1976
2	3422.	140520.	37285.	364.	457.	2882.	1750.	466169.
3	7891.	2801.	115047.	30525.	297.	313.	2357.	1421.
4	4680.	6449.	2292.	94183.	24986.	242.	255.	1546.
5	725.	3829.	5264.	1849.	75640.	20436.	194.	182.
6	16319.	592.	3117.	4298.	1391.	57835.	16614.	144.
7	847.	13302.	455.	2545.	3469.	900.	38714.	11743.
8	309.	691.	10612.	335.	2058.	2415.	601.	23719.
9	119.	252.	542.	8410.	203.	1562.	1909.	367.
10	455.	97.	193.	414.	6561.	130.	1242.	1118.
11	823.	370.	65.	146.	278.	5201.	94.	765.
12	28.	670.	264.	48.	99.	220.	3730.	60.
13	22.	22.	471.	201.	30.	78.	158.	2354.
14	17.	17.	17.	355.	138.	24.	56.	99.
15	13.	13.	13.	13.	237.	109.	17.	35.
16	10.	10.	10.	10.	10.	188.	78.	10.
17	7.	7.	7.	7.	7.	7.	134.	50.
18	5.	5.	5.	5.	5.	5.	5.	84.
BIOMASS (5+)	4873	4952	5384	4933	19378	21480	16358	11237
F (5+)	.01	.03	.03	.05	.07	.14	.25	.25

STOCK PROJECTION AREA A+B SPRING SPAWNERS '0000

NATURAL MORTALITY# 0.2000 YEAR 1976

AGE	POP. NO. %X10-3<	CATCH NO. %X10-3<	FISHING MORT.	MEAN WT. KG.	POP. WT. %METRIC TONS<	CATCH WT. %METRIC TONS<	RESIDUAL POP. NOS.
2	15768.	12.	0.001	0.075	1182.6	0.9	12896.8
3	284.	3.	0.012	0.133	37.8	0.4	229.7
4	1112.	61.	0.063	0.172	191.3	10.5	854.8
5	194.	25.	0.153	0.197	38.2	4.9	136.3
6	405.	82.	0.252	0.221	89.5	18.1	257.7
7	5106.	1028.	0.251	0.240	1225.4	246.7	3252.5
8	8135.	1638.	0.251	0.254	2066.3	416.1	5181.9
9	643.	130.	0.252	0.266	171.0	34.6	403.2
10	1641.	330.	0.250	0.289	474.2	95.4	1046.4
11	4104.	826.	0.250	0.321	1317.4	265.1	2615.8
TOTAL	37392.	4135.			6793.7	1092.7 (x1.14)	26862.2

NATURAL MORTALITY# 0.2000 YEAR 1977

AGE	POP. NO. %X10-3<	CATCH NO. %X10-3<	FISHING MORT.	MEAN WT. KG.	POP. WT. %METRIC TONS<	CATCH WT. %METRIC TONS<	RESIDUAL POP. NOS.
2	2050.	6.	0.003	0.075	153.7	0.4	1673.0
3	12897.	174.	0.015	0.133	1715.3	23.2	10401.8
4	230.	15.	0.075	0.172	39.5	2.6	174.5
5	855.	128.	0.180	0.197	168.4	25.2	564.6
6	136.	32.	0.300	0.221	30.1	7.1	82.7
7	258.	61.	0.300	0.240	61.9	14.6	155.3
8	3252.	768.	0.300	0.254	826.1	195.0	1972.7
9	5182.	1223.	0.300	0.266	1378.4	325.4	3143.0
10	409.	97.	0.300	0.289	118.3	27.9	248.2
11	1046.	247.	0.300	0.321	335.9	79.3	634.6
12	2617.	618.	0.300	0.321	840.0	198.3	1587.2
13	0.	0.	0.300	0.321	0.0	0.0	0.0
14	0.	0.	0.300	0.321	0.0	0.0	0.0
15	0.	0.	0.300	0.321	0.0	0.0	0.0
TOTAL	28932.	3368.			5667.5	899.1	20658.6

(10 250)

STOCK PROJECTION AREA C SPRING SPAWNERS '0000 — App. II - Table 2

NATURAL MORTALITY# 0.2000 YEAR 1976

AGE	POP. NO. %X10-3<	CATCH NO. %X10-3<	FISHING MORT.	MEAN WT. KG.	POP. WT. %METRIC TONS<	CATCH WT. %METRIC TONS<	RESIDUAL POP. NOS.
2	13687.	1.	0.001	0.080	1095.0	0.1	11194.8
3	743.	7.	0.011	0.119	88.4	0.8	601.7
4	678.	30.	0.051	0.150	101.7	4.5	527.5
5	100.	10.	0.117	0.185	18.5	1.8	72.8
6	60.	10.	0.203	0.232	13.9	2.3	40.1
7	2069.	341.	0.200	0.248	513.1	84.6	1356.9
8	7836.	1292.	0.201	0.255	1998.2	329.5	5247.4
9	390.	64.	0.200	0.277	108.0	17.7	261.4
10	379.	62.	0.199	0.291	110.3	18.0	254.3
11	1539.	254.	0.201	0.334	514.0	84.8	1030.6
TOTAL	27481.	2071.			4561.1	544.2 (x1.17)	20617.4

NATURAL MORTALITY# 0.2000 YEAR 1977

AGE	POP. NO. %X10-3<	CATCH NO. %X10-3<	FISHING MORT.	MEAN WT. KG.	POP. WT. %METRIC TONS<	CATCH WT. %METRIC TONS<	RESIDUAL POP. NOS.
2	610.	2.	0.003	0.080	48.8	0.1	498.0
3	11195.	151.	0.015	0.119	1332.2	18.0	9029.0
4	602.	39.	0.075	0.150	90.2	5.9	457.0
5	527.	79.	0.180	0.185	97.6	14.6	360.7
6	73.	17.	0.300	0.232	16.9	4.0	44.2
7	40.	9.	0.300	0.248	9.9	2.3	24.3
8	1387.	327.	0.300	0.255	353.7	83.5	841.2
9	5247.	1239.	0.300	0.277	1453.5	343.2	3182.7
10	261.	62.	0.300	0.291	76.1	18.0	158.6
11	254.	60.	0.300	0.334	84.9	20.1	154.2
12	1031.	243.	0.300	0.334	344.2	81.3	625.1
13	0.	0.	0.300	0.334	0.0	0.0	0.0
14	0.	0.	0.300	0.334	0.0	0.0	0.0
15	0.	0.	0.300	0.334	0.0	0.0	0.0
TOTAL	21228.	2229.			3908.1	590.9	15375.1

(6900)

APP. II - Table 3

STOCK PROJECTION AREA D SPRING SPAWNERS '0000

NATURAL MORTALITY# 0.2000 YEAR 1976

AGE	POP. NO. %X10-3<	CATCH NO. %X10-3<	FISHING MORT.	MEAN WT. KG.	POP. WT. %METRIC TONS<	CATCH WT. %METRIC TONS<	RESIDUAL POP. NOS.
2	8137.	1.	0.001	0.080	651.0	0.1	6655.4
3	74.	1.	0.016	0.146	10.8	0.1	59.6
4	297.	20.	0.078	0.157	46.6	3.1	224.9
5	12.	2.	0.203	0.201	2.4	0.4	8.0
6	29.	7.	0.308	0.234	6.8	1.6	17.4
7	646.	153.	0.302	0.254	164.1	38.9	391.0
8	3345.	790.	0.301	0.269	899.8	212.5	2026.8
9	114.	27.	0.302	0.285	32.5	7.7	69.0
10	100.	24.	0.306	0.307	30.7	7.4	60.3
11	758.	179.	0.301	0.355	269.1	63.5	459.3
TOTAL	13512.	1204.			2113.8	335.4 (x 1.07)	9971.8

NATURAL MORTALITY# 0.2000 YEAR 1977

AGE	POP. NO. %X10-3<	CATCH NO. %X10-3<	FISHING MORT.	MEAN WT. KG.	POP. WT. %METRIC TONS<	CATCH WT. %METRIC TONS<	RESIDUAL POP. NOS.
2	58.	0.	0.003	0.080	4.6	0.0	47.4
3	6655.	90.	0.015	0.146	971.7	13.1	5367.8
4	60.	4.	0.075	0.157	9.4	0.6	45.3
5	225.	34.	0.180	0.201	45.2	6.8	153.8
6	8.	2.	0.300	0.234	1.9	0.4	4.9
7	17.	4.	0.300	0.254	4.4	1.0	10.6
8	391.	92.	0.300	0.269	105.2	24.8	237.2
9	2027.	478.	0.300	0.285	577.6	136.4	1229.3
10	69.	16.	0.300	0.307	21.2	5.0	41.9
11	60.	14.	0.300	0.355	21.4	5.1	35.6
12	459.	108.	0.300	0.355	163.0	38.5	278.6
13	0.	0.	0.300	0.355	0.0	0.0	0.0
14	0.	0.	0.300	0.355	0.0	0.0	0.0
15	0.	0.	0.300	0.355	0.0	0.0	0.0
TOTAL	10030.	843.			1925.7	231.8	7453.2

(2500)

APP. II - Table 4

STOCK PROJECTION AREA E+F SPRING SPAWNERS '0000

NATURAL MORTALITY# 0.2000 YEAR 1976

AGE	POP. NO. %X10-3<	CATCH NO. %X10-3<	FISHING MORT.	MEAN WT. KG.	POP. WT. %METRIC TONS<	CATCH WT. %METRIC TONS<	RESIDUAL POP. NOS.
2	7000.	106.	0.017	0.080	560.0	8.5	5634.5
3	142.	2.	0.016	0.179	25.4	0.4	114.4
4	155.	9.	0.067	0.195	30.2	1.8	118.7
5	18.	2.	0.131	0.203	3.7	0.4	12.9
6	14.	3.	0.269	0.242	3.4	0.7	8.8
7	1174.	236.	0.250	0.235	275.9	55.5	748.6
8	2372.	478.	0.251	0.278	659.4	132.9	1510.9
9	39.	8.	0.256	0.285	11.1	2.3	24.7
10	112.	23.	0.256	0.291	32.6	6.7	71.0
11	348.	70.	0.250	0.335	116.6	23.4	221.9
TOTAL	11374.	937.			1718.3	232.5 (x1.07)	8466.4

NATURAL MORTALITY# 0.2000 YEAR 1977

AGE	POP. NO. %X10-3<	CATCH NO. %X10-3<	FISHING MORT.	MEAN WT. KG.	POP. WT. %METRIC TONS<	CATCH WT. %METRIC TONS<	RESIDUAL POP. NOS.
2	436.	1.	0.003	0.080	34.9	0.1	355.9
3	5635.	76.	0.015	0.179	1008.6	13.6	4544.5
4	114.	8.	0.075	0.195	22.3	1.5	85.9
5	119.	18.	0.180	0.203	24.1	3.6	81.2
6	13.	3.	0.300	0.242	3.1	0.7	7.8
7	9.	2.	0.300	0.235	2.1	0.5	5.3
8	749.	177.	0.300	0.278	208.1	49.1	454.0
9	1511.	357.	0.300	0.285	430.6	101.7	916.4
10	25.	6.	0.300	0.291	7.2	1.7	15.0
11	71.	17.	0.300	0.335	23.8	5.6	43.1
12	222.	52.	0.300	0.335	74.3	17.5	134.6
13	0.	0.	0.300	0.335	0.0	0.0	0.0
14	0.	0.	0.300	0.335	0.0	0.0	0.0
15	0.	0.	0.300	0.335	0.0	0.0	0.0
TOTAL	8902.	716.			1839.1	195.7	6644.7

(2100)

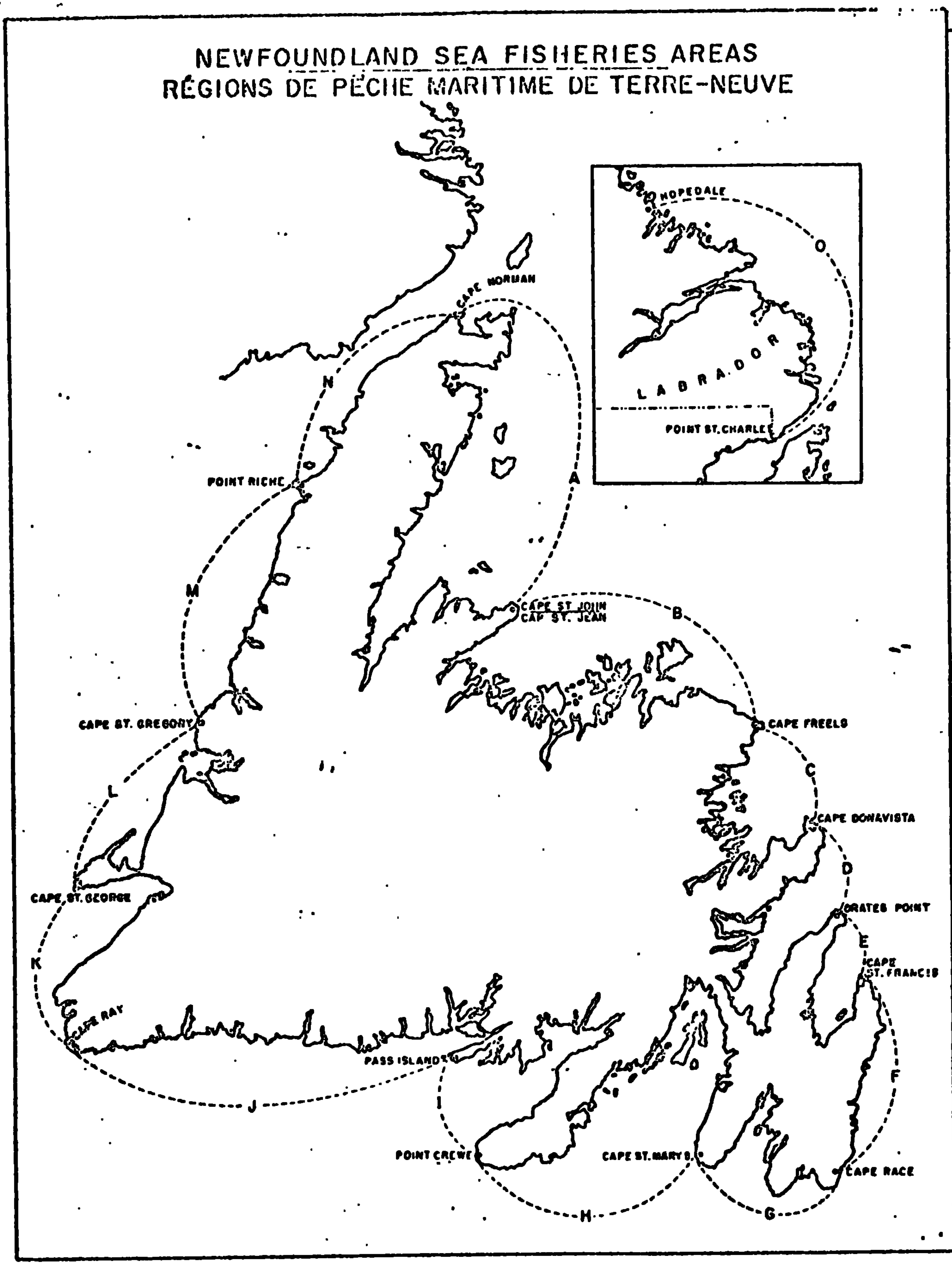

Fig. 1. Area map of Newfoundland

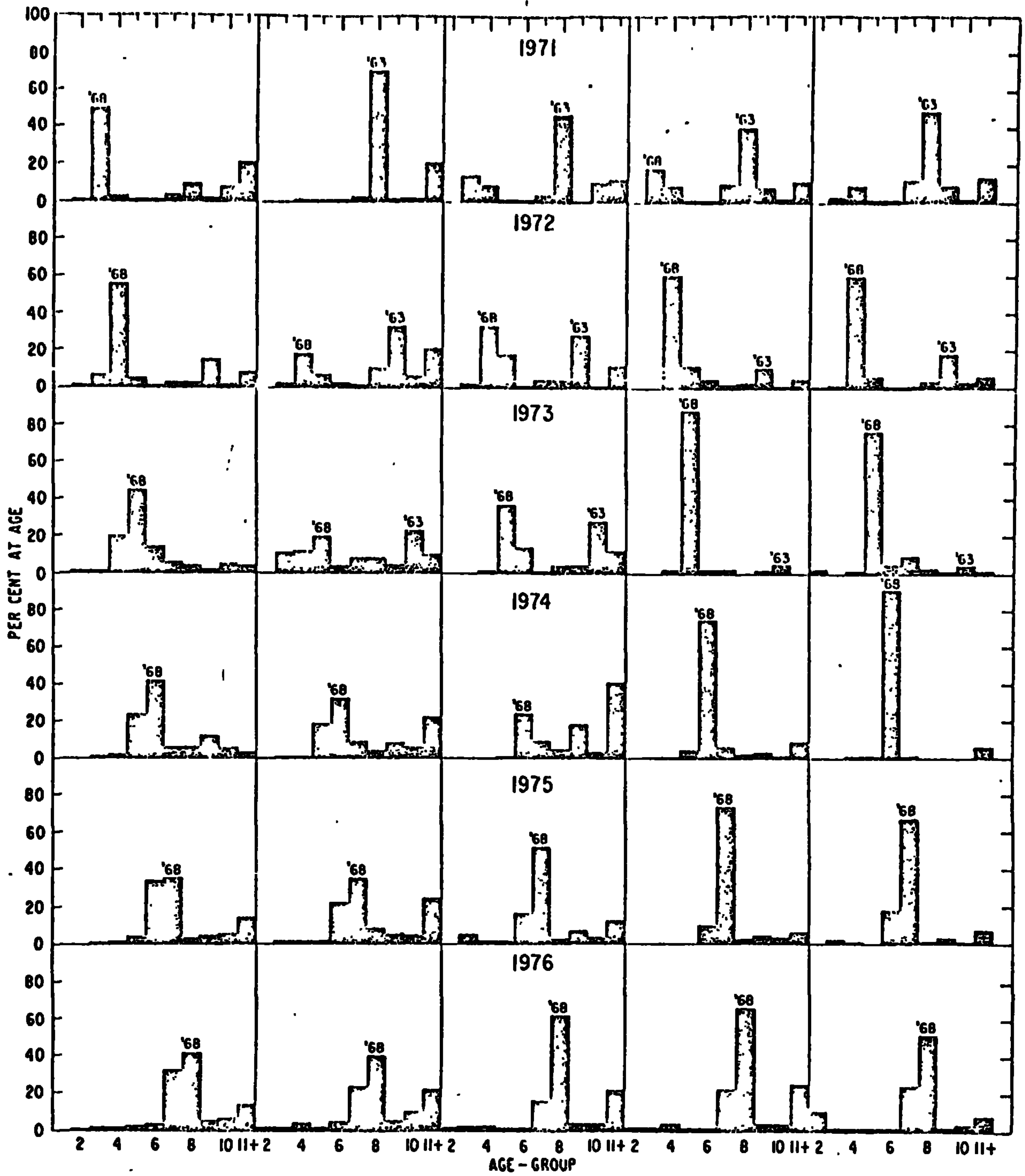

Fig. 2. Age composition data (spring-spawners) of eastern Newfoundland herring stocks.

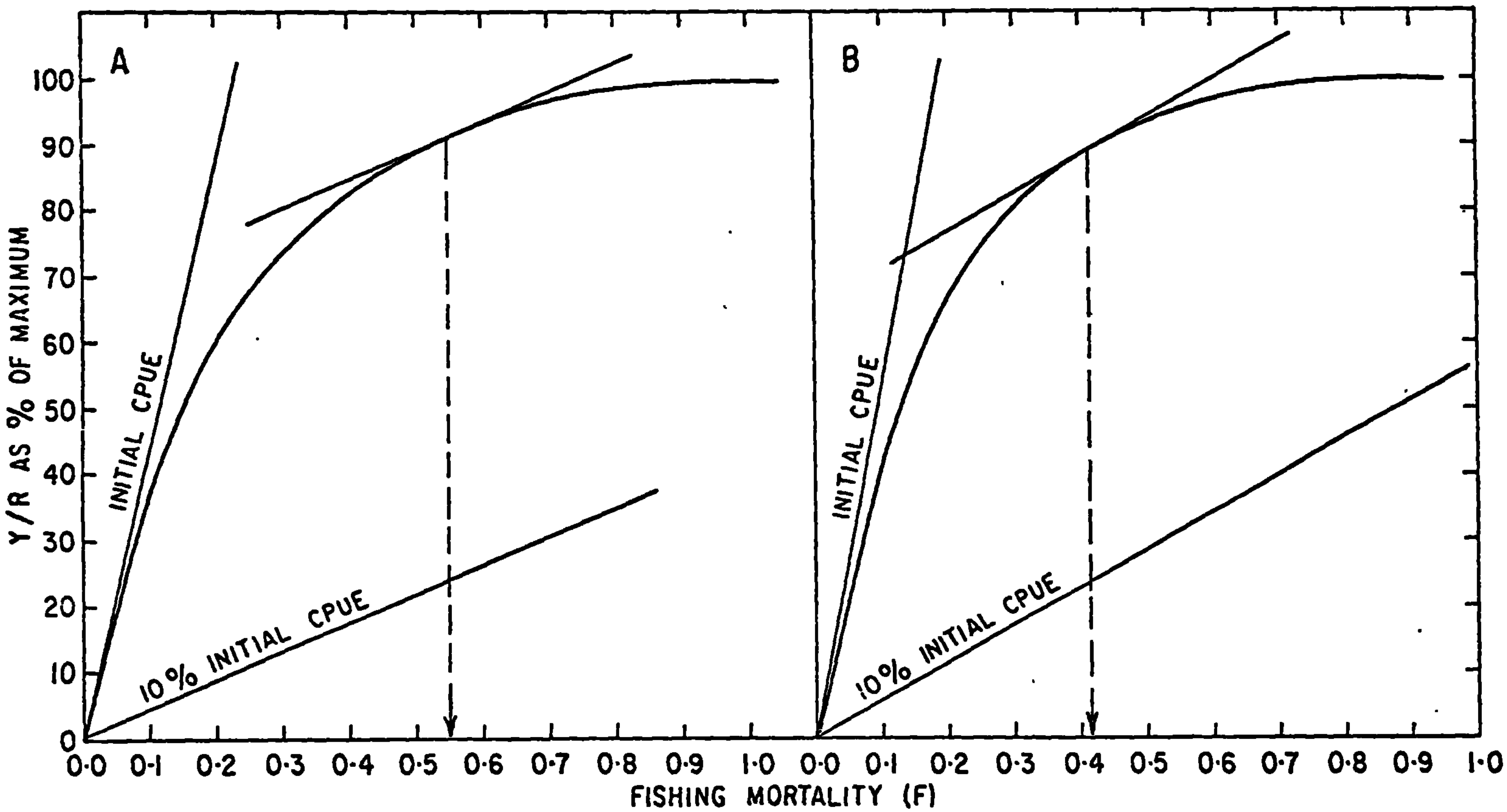

Fig. 3. Yield-per-recruit curves of eastern Newfoundland herring stocks under two assumptions of partial recruitment;
(A) 1%, 5%, 25%, 60%, 100% for ages 2 - 6 respectively
(B) 1%, 30%, 50%, 100% for ages 2 - 5 respectively.

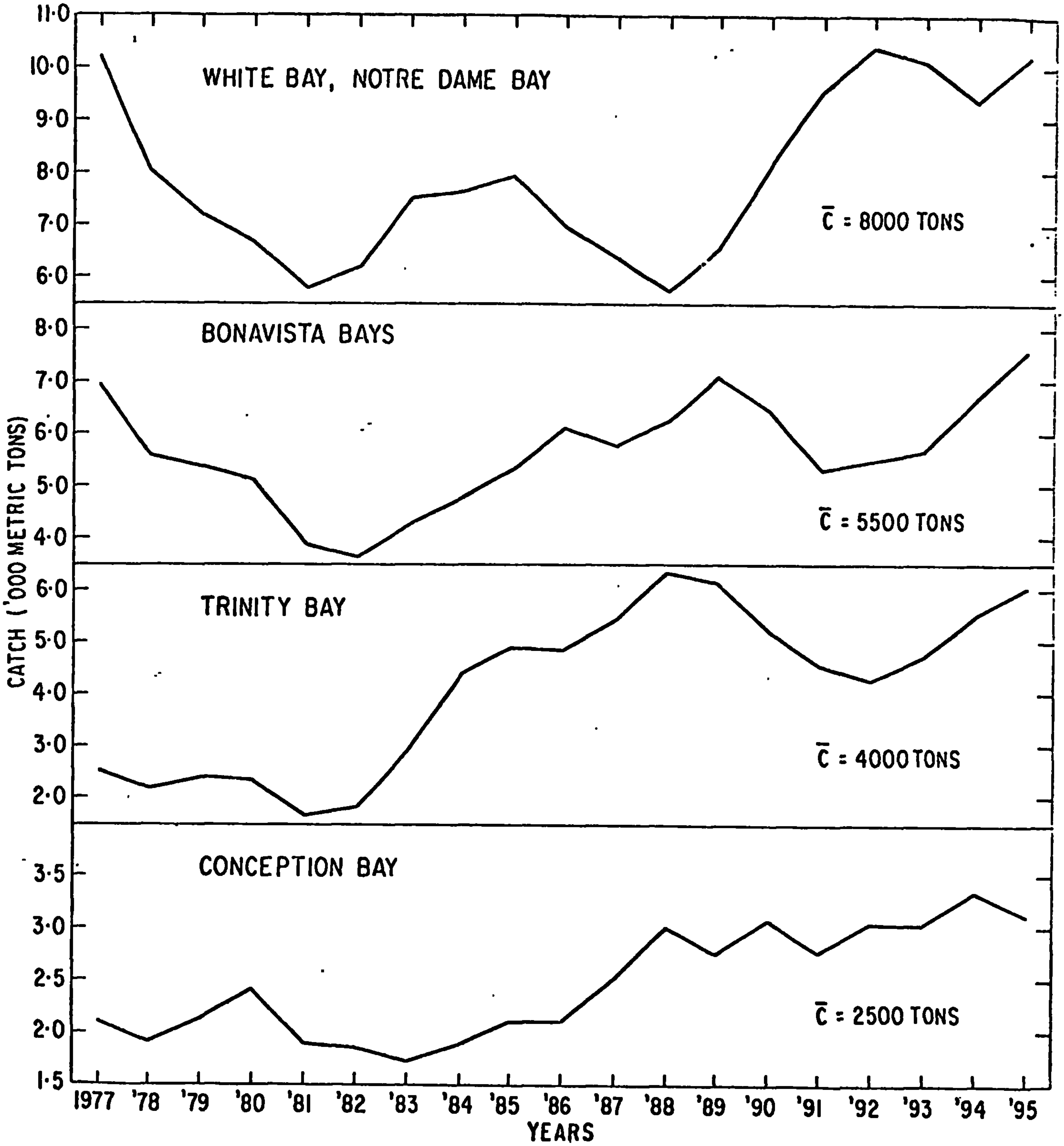

Fig. 4. Catch projections, 1976-95, at $F_{0\cdot1}$ = 0.30 for the various stock complexes of herring along eastern Newfoundland.

CAFSAC
Subcommittee Rept. 77/12

CAFSAC

STATISTICS, SAMPLING AND SURVEY SUB-COMMITTEE

REPORT OF MEETING

QUEBEC CITY

NOVEMBER 8, 1977

Attendance: W. Doubleday - Chairman
J. Boulva - Rapporteur
D. Barret
R. Boudreault
G. Carpentier
P.L. Ellis
L. Feltham
D.N. Fitzgerald
J. Fréchette
P. Hart
J.P. Lussiaà-Berdou
W. Marshall
T.K. Pitt
D. Tilley
D. Waldron
R. Wells

The meeting was convened at the F.M.S. Quebec regional office. Documents distributed for discussion are listed in Appendix A and have been included in the CAFSAC working paper series, with the exception of one ICNAF Summary Document.

STRATIFICATION OF THE GULF OF ST. LAWRENCE (GROUNDFISH AND SHRIMP)

1. Groundfish

a) Maritimes. A stratification scheme in fathoms for the Southern Gulf was introduced in 1970, and is based on depth zones and has been used since for about 10 groundfish cruises mainly in September.

b) Quebec. The province of Québec developed a groundfish stratification scheme in 1976 for the northern Gulf of St. Lawrence, using the depth contours of 100, 200 and 400 meters. Computer programs are available to produce charts with isobaths. Three cruises have been completed using this system. The addition of a 300 meter contour is under consideration.

c) Newfoundland. St. John's Laboratory has completed in 1977 a scheme for the northern Gulf and one cruise was done this September. The scheme is based on depth contours of 50 - 100, 100 - 150, 150 - 200 and greater than 200 fathoms and defines 33 strata which are broken down in rectangles of 32 - 33 square nautical miles. Random selection of stations is done by computer.

2. Shrimp

The province of Québec introduced a stratification scheme for the northwest Gulf in 1974. Two cruises, one in April and the other in October had been made from 1974 to 1976 using this scheme, another one in April 1977. There are 13 strata based on fathoms depths over a 1500 sq. mi. area in the N.W. Gulf scheme. Another scheme was introduced in 1977 for the Anticosti Channel over an area of 2603 sq. mi. One cruise used that scheme in November 1977.

In the absence of E.J. Sandeman from Newfoundland, it was not possible to have a full discussion on a stratification scheme for shrimps in the northern Gulf. It was agreed that the matter should be discussed either at a future SSSS meeting or directly between S. Sandeman and J. Fréchette.

3. Discussion

A discussion followed in which the points below were raised:

- Direct comparisons of abundance estimates from one survey to another are hazardous.

- To compare overall abundance estimates, it does not matter if one scheme is in metric and has different strata boundaries than the other scheme. Both Quebec and Newfoundland schemes allow aggregation by ICNAF division.

- The division line of 4T is not clearly indicated in the scheme of St. Andrews.

- Quebec needs to add part of 4T to its scheme to cover redfish completely.

- No conflict is seen between the Maritimes and the Quebec or Newfoundland schemes.

- Stratification schemes, in some instances, do not cover depths less than 50 fathoms because of the presence of fixed gear or rough bottoms.

- If station latitudes and longitudes are given, it is simple then to transfer from one scheme to another, at least within an ICNAF division.

- Adopting the Quebec scheme would mean a lot of expensive hand work for Newfoundland; adopting the Newfoundland scheme would mean a lot of expensive computer work for Quebec (digitization of fathoms isobaths and quadrangles boundaries).

- Quebec is willing to discuss the possibility of access, by St. John's to its computer programs and data base for the Gulf stratification, and to supply upon request a copy of its master chart.

- St. John's is willing to provide similar information to Quebec.

- The objectives for Quebec in selecting depth zones is to improve precision of abundance estimates and also to allow comparisons of species biometric data between various depth ranges mainly for cod and redfish.

- The Newfoundland stratification scheme is aimed at cod and redfish abundance estimation.

- Even though a metric scheme has long-term advantages due to the switchover to metric by the Hydrographic Service, it will be simple to continue using stratification charts prepared in fathoms.

The Sub-committee recognizes that a single stratification scheme for the Gulf of St. Lawrence would be preferable and that it would facilitate coordination of research between the various laboratories involved; discussions compared the long-term advantages of shifting to a computerized scheme in metrics to the high cost of changing over but no definite conclusion was reached.

4. Numbering of strata

The numbering of stratification schemes is a common problem to 4T, as well as to the Gulf and the whole of the N-W.Atlantic, mainly due to overlap in numbers.

The Sub-committee recommends:

a) that St. John's examine the possibility of adopting St. Andrews numbering system in 4T and numbers L to L4 in the deep water of the Laurentian channel in 4T;

b) that St. Andrews adopt St. John's strata boundaries in 4T;

c) that various laboratories consider using number series which do not overlap.

PROGRESS TOWARDS 1977 FOREIGN LOG RECORD PROCESSING

1. Staffing Action for Processing of Log Records

Processing of log records has not been initiated due to lack of availability of those man years requested; processing of logs had been scheduled to start by late September 1977. Further, few logs for 1977 are now available. The Sub-Committee feels temporary man years would be of little use due to the long time required to train personnel for such a task.

The Sub-committee requests the Chairman to examine the possibility of obtaining permanent man years for processing log books.

2. Proposed format

The draft of the international fishing log to be used in the Canadian management zone is to be revised by Mr. Tilley and re-submitted to the Sub-committee, taking into account the following recommendations:

a) create a numbering scheme for the various entries

b) include enough boxes for writing digits of the Canadian licence number (6 digits recommended rather than 8)

c) indicate precision wanted for latitudes and longitudes

d) depth of each set should be added to the form

e) total kept and discarded for each set to be added on the right side of the form

f) a box to indicate main species sought to be added to the upper right corner of the form

g) position at start rather than end of set is needed

h) should be less lines for sets so the form will fit on a sheet 8 1/2 x 14 inches

i) if a loose leaf format is adopted, each form should be pre-numbered

j) the names of the five more important species by volume should be printed on top of the first five columns in the "Catch by species" table

k) replace, on lower left side, "Quantity of round fish used for . . ." by "Roundweight equivalent processed for human consumption today" and "Roundweight equivalent processed for reduction (meal)".

l) MAKE TRANSFER FORM SEPARATE FROM LOG BOOK. Rewriting of pertinent information on the transfer forms will be necessary

m) replace "Products transferred to ☐ from ☐ other vessels" by "Products landed ☐ or transferred to ☐ from ☐ other vessels".

n) in list of products landed or transferred, delete "Fresh fillets" and write "Salt fish"

o) a species list should be included in the transfer form

p) names of "other vessels" should include Canadian licence number and side number

The Sub-committee further requests that Mr. Tilley forward for comments to surveillance in Newfoundland and Maritimes the draft titled "Valid status codes" and that on the basis of suggestions received, a new draft of recommended codes be prepared.

The Sub-committee concluded that 6 digits rather than 8 would be sufficient for the Canadian licence number, as one digit rather than two is sufficient for country identification and no digit is needed for check as this is provided by the vessel's side number.

3. Processing of the Forms

The Sub-committee is not prepared to discuss key entry and coding procedures, and therefore requests Messrs. G. Collins and L. Feltham to prepare a working paper on the subject for the next SSSS meeting.

4. Edit Program Specifications

As a consequence of the discussions of the Sub-committee, a major revision of the document is needed. The following points have been raised:

a) P.1, flow chart should run on a monthly cycle "Log records" need clarification and a box should be added for "rejected transactions".

b) Appendix II; Edit rules:

(3) and (4) - add check to verify that position reported here is in ICNAF division indicated in (5)

(8) - discussion on vessel status "searching" was postponed to the next meeting

(11) - add check to flag discard rate if it exceeds a given percent (to be decided upon) of the total catch

(13) - add check to see if a species reported from a given area can actually occur there according to Appendix IX.

"(14)" - to be added, to extrapolate latitude and longitude of end of set, knowing the coordinates of the start.

"(15)" - add "depth".

c) Appendix III - Record format description. Discussions are postponed due to major revision of the draft form.

. . ./6

d) Appendix V - List of ICNAF division codes. Add ICNAF area 0 and delete ICNAF area 6; add Canadian fishing zone 6 which covers the Arctic waters.

e) Appendix VI - Valid status codes - to be revised by Mr. Tilley as indicated above.

f) Appendix VII - Gear codes. It was suggested to remove those gears which do not apply to the NW Atlantic, but after some discussions, it was agreed to retain the list as it stands. The codes will be adjusted by the data base administrator; this matter to be referred to D. Waldron and D. Tilley.

g) Appendix VIII - Species code. See below.

h) Appendix X - Record format description. Previous year's Canadian licence number is needed to allow following individual vessels. Add also: number of crew horsepower and age of vessel.

i) Appendices I, IV and IX were not discussed.

5. Possible Role of FLASH in processing Foreign Fishing Logs

The Sub-commitee agreed that FLASH should supply:

a) to each region a list of vessels licenced by that region whose log books are due this month.

b) a sampling report on a regular basis, indicating total catch and effort and gear used, if possible by vessel tabled by country

c) the regions with a list of vessels which reported being in each simple area the previous month if the computer system for log records is not functioning.

Further, the Sub-committee agrees to allow access of FLASH to the master file.

Further discussions raised the suggestion that "sightings" noted by FLASH should specify "sighted fishing" or "sighted sailing".

6. Importance of Log Records for Surveillance

The usefulness of log record data to audit surveillance and quota management reporting of the foreign fleet was noted.

CONVERSION FACTORS FOR FOREIGN WET AND PROCESSED WEIGHTS (Preliminary Considerations)

The Sub-committee discussed the availability of conversion factors and observed that stock, seasonal and other variations in conversion factors are to be anticipated. Conversion factors are available for most species and products but often are out of date.

The Sub-committee agrees that available conversion factors should be revised and recommends that the necessary field program for such a revision be initiated.

SPECIES CODES

The Sub-committee examined the advantages and disadvantages of three species codes: ICNAF numeric, FAO taxonomic and ICES alpha. No clear conclusion was reached but it was tentatively proposed that the three alpha code be adopted.

A national data dictionary is to be prepared for the Fisheries and Marine Service, and is to include a species code, the nature of which is still unknown; it is possible that all Canadian government organizations may have to use this latter code.

NEXT MEETING

It was tentatively proposed that the next meeting take place in St. John's, Newfoundland during the second week of January, 1978.

APPENDIX I

Documents Submitted:

CAFSAC WORKING PAPER	TITLE	AUTHOR
77-41	Stratification scheme for groundfish used in the Southern Gulf by the Maritime Region	D.N. Fitzgerald
77-42	Stratification scheme for groundfish used in the Northern Gulf by the Direction générale des pêches maritimes Ministère de l'industrie et du commerce du Québec.	J.P.Lussiaà-Berdou
77-43	Draft form for international fishing log	D. Tilley & P. Hart
77-44	List of Northwest Atlantic species arranged according to the ICNAF groups	anonymous
77-45	International logs (to be revised)	L. Feltham
77-46	Notes on possible role of FLASH in processing foreign fishing logs	P.L. Ellis
ICNAF Summ. Dec 77/XI/36	Three-alpha code for use in logbooks to identify North Atlantic species names.	Assistant Executive Secretary ICNAF

VESSEL NAME	03 SIDE NUMBER	CANADIAN LICENCE NUMBER	REMARKS: (Include reasons for not fishing and details of trans-shipments)

DATE DAY MONTH YEAR	NOON POSITION (GMT) LATITUDE LONGITUDE	ICNAF DIVISION 3	10 TYPE OF GEAR

SET NO.	TIME SET BEGAN	TIME SET FINISH	HOURS FISHED 41	NUMBER OF NETS OR LINES HAULED	CATCH BY SPECIES KILOGRAMS-ROUND WEIGHT								
					SPECIES								
1					KEPT								
					DISCARDED								
2					KEPT								
					DISCARDED								
3					KEPT								
					DISCARDED								
4					KEPT								
					DISCARDED								
5					KEPT								
					DISCARDED								
6					KEPT								
					DISCARDED								
7					KEPT								
					DISCARDED								
8					KEPT								
					DISCARDED								
9					KEPT								
					DISCARDED								
10					KEPT								
					DISCARDED								
TOTAL	X	X			KEPT								
					DISCARDED 63								

[illegible] Give quantities of round fish
[illegible] for human consumption or reduction.
[illegible] amounts recieved from other vessels.

PRODUCTION									
SPECIES									
HUMAN CONSUMPTION 61									
REDUCTION 62									

MASTER'S SIGNATURE