INTERNATIONAL COMMISSION

FOR THE

NORTHWEST ATLANTIC FISHERIES

REDBOOK 1969

PART III SELECTED PAPERS FROM THE 1969 ANNUAL MEETING

Issued from the Headquarters of the Commission
Dartmouth, N. S., Canada

1969

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Note

REDBOOK 1969 appears in 3 books. The first book contains Part I, Proceedings of the Standing Committee on Research and Statistics. The second book contains Part II, Reports on Researches in the ICNAF Area in 1968. The third book contains Part III, Selected Papers from the 1969 Annual Meeting.

prepared by Valerie L. Caton and Jean S. Maclellan

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CONTENTS

PART III. SELECTED PAPERS FROM THE 1969 ANNUAL MEETING

CONTENTS
(continued)

SECTION A
COD

1. Observations on the stock of cod off Labrador (Div. 2J) and Newfoundland (Div. 3K) in the years 1963-1968[1]

by Eugeniusz Stanek
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Introduction

Polish fishing operations in the Northwest Atlantic began in 1960 when factory trawlers (over 2784 GRT) were introduced. The number of this type of vessel in operation increased steadily as well as their fishing effort and the quantity of cod landed (Tables 1 and 2). The catches of this species increased from 1,222 m tons in 1961 to 91,008 tons in 1968.

Table 1. Fishing effort (hours fished) in Polish operations in the Northwest Atlantic and in Div. 2J and 3K in 1961-1968.

	1961	1962	1963	1964	1965	1966	1967	1968
NW Atlantic	2,488	5,245	10,733	20,331	26,838	28,843	42,367	47,424
2J	290	363	934	4,123	7,553	7,715	13,733	15,643
3K	-	1,119	6,917	13,839	8,797	9,797	7,027	21,844

Until 1964 inclusive, the main object of Polish fisheries was redfish. Cod was of minor importance. More attention was paid to cod first in 1965 when it became the main component of Polish catches (Table 3.)

Of the total catch of cod landed from the whole ICNAF area since 1966 48.9 - 56.3% were from southern Labrador (Div.2J) and 9.2-18.3% from the northern part of Newfoundland (Div.3K). The remainder up to 100%, was landed from other ICNAF Divisions. Thus Div. 2J and 3K are the main fishing grounds for Polish catches of cod in the Northwest Atlantic. According to Templeman (1962) the cod in these Divisions belong to the same stock.

Catches and fishing yield of cod

Div. 2J

Here in 1961-1968, the number of hours of trawling increased from 290 to 15,643 and the landings of cod increased from 458 to 51,301 tons. Detailed data are given in Tables 1 and 2. Particularly high yield was obtained in 1968. Yield in the winter of 1968 (4,663 kg per 1 hour) was double that in the same season in 1967 (2,330 kg per 1 hour trawling).

As a rule the period January-March was the season of the highest catch and the best fishing yield of cod in Polish fishing operations in Div.2J. Sometimes this season extended to include April (Table 3). The decrease in yield in April was the result of migration of fish northward to the spawning

[1] submitted to the 1969 Annual Meeting of ICNAF as ICNAF Res.Doc.69/58

grounds where ice conditions hampered operations. More intensive exploitation of spawning concentrations of cod commenced in 1967 and good fishing yields were still being obtained in May. Fishing yield began to decrease in June and the fishing fleet shifted towards southern Divisions.

Table 2. Polish catches of cod (in metric tons) from the fishing grounds of the northwest Atlantic, 1961-1968.

Divisions	1961	1962	1963	1964	1965	1966	1967	1968
				Subarea 1				
Total	-	484	274	92	38	799	625	861
				Subarea 2				
2G	-	-	-	-	-	-	1,039	925
2H	-	30	-	-	2,585	11,884	8,504	17,519
2J	358	921	703	2,058	8,614	17,866	28,592	51,301
Total	358	951	703	2,058	11,199	29,750	38,135	69,745
				Subarea 3				
3K	-	1,004	4,363	7,710	1,718	4,454	4,286	16,682
3L	528	680	428	240	910	305	5,849	1,004
3M	336	888	1,875	717	5,079	93	4,152	71
3N	-	12	-	-	77	613	3,255	6
30	-	-	41	-	-	152	290	-
3P	-	-	32	-	-	9	-	-
Total	864	2,584	6,739	8,667	7,784	5,626	17,832	17,763
				Northwest Atlantic area*				
Total	1,222	4,019	7,737	10,866	21,719	36,448	57,663	91,008

* Including some small catches of cod in Subareas 4 and 5.

Div. 3K

Here the catch of cod and the fishing yield increased as follows: from 1,119 hours and 1,004 tons in 1962 to 21,844 hours and 16,682 tons in 1968 (Tables 1 and 2).

The mean annual fishing yield of cod in the years 1962-1968 fluctuated from 160 kg (1965) to 898 kg per 1 hour trawling (1962).

The low fishing yields in 1965 were probably related to warming of the Labrador Current, which commenced in that year and continued until the middle of 1967 (Postolaky, 1967); Konstantinov, 1968). In these circumstances cod left Div.3K in greater than usual numbers, migrating northward to higher latitudes off Labrador, thus causing the decrease of yield in 3K.

Table 3. Yield of cod (kg/hr) of Polish factory trawlers in Div.2J, 1961-1968.

Years	Months												Total		
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.-June	July-Dec.	Jan.-Dec.
1961													1,233	-	1,233
1962													3,724	1,034	2,538
1963	-	4,800	-	1,050	760	100	140	310	-	80	-	-	1,006	141	750
1964	1,820	2,110	3,190	2,230	40	250	-	310	90	50	-	1,810	1,362	116	500
1965	4,060	3,230	20	160	1,090	350	120	60	10	-	-	-	2,595	75	1,140
1966	3,935	3,960	2,112	1,617	1,691	1,096	-	-	-	764	792	1,283	2,813	1,043	2,316
1967	2,460	2,473	1,189	1,531	3,007	1,109	-	-	-	907	798	1,766	2,301	1,054	2,082
1968	5,234	4,915	4,350	2,756	2,296	1,793	818	-	900	769	-	-	3,502	972	3,279

Table 4. Yield of cod (kg/hr) of Polish factory trawlers in Div.3K, 1961-1968.

Years	Months												Total		
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.-June	July-Dec.	Jan.-Dec.
1961													-	-	-
1962													1,075	280	898
1963	2,110	1,590	-	1,020	600	730	180	620	460	60	310	290	935	389	650
1964	1,270	1,140	1,330	590	150	420	470	320	650	70	210	280	783	305	560
1965	630	350	200	120	350	70	60	380	170	1,270	-	710	211	131	190
1966	-	868	732	148	1,076	66	118	422	62	396	346	811	543	319	459
1967	1,708	1,419	452	205	400	136	288	83	461	675	714	389	491	644	610
1968	2,250	10,200	2,032	1,001	206	1,453	546	952	437	465	686	396	1,163	634	764

Fairly good results were obtained in autumn 1967 (389 - 714 kg per 1 hour trawling) and in winter 1968 (2,032 kg), whereas exceptional yields of 10,200 kg per 1 hour trawling was obtained in February of this year. The yields obtained in the whole winter season of 1968 (2,672 kg per 1 hour trawling) were almost three times higher than those obtained in the same season of the previous year (894 kg per 1 hour).

Length and age composition of cod

Observations on length and age composition of cod in Div.2J and 3K have been carried out since 1963 (except for 1965 for which the data are lacking). These observations were made in various seasons generally aboard factory trawlers. Only in 1964 were they carried out aboard research vessels. The length and age composition of the commercial stock is shown in Fig. 1 and 2.

Length and age composition in 2J

In the commercial stock cod were generally 29 cm to 71 cm in length and 3 to 9 years old (Fig. 1). In particular years differences in age and length composition of cod were noted depending on the abundance of year-classes.

In 1963 and 1967 the samples were comprised mainly of fish 42 to 65 cm in length (mean length 53.6 cm and 51.6 cm) and of 5 to 7 years of age.

In 1964 and 1966 a considerable number of smaller and younger fish were noted. Their length ranged from 30 to 62 cm (mean length 45.8 cm and 49.5 cm); their age from 3 to 8 or 7 years.

In 1968 fish were mostly 41 to 68 cm in length (mean length 53.9 cm) and 4 to 8 years old.

In the samples taken in July 1964 there were a large number of 5 year old cod, belonging to abundant 1959 year-classes. These fish occurred also in 1966 in large numbers as 7 year olds. The 6 year old cod (1961 year-class) were particularly abundant in 1967. The 1962 and 1964 year-classes caught as 4 years old fish in the years 1966 and 1968 also seemed to be abundant.

Length and age composition in 3K

Cod caught in Div.3K were somewhat larger than cod from Div.2J. In Div.3K most of the fish were 36 to 71 cm and ranged from 4 to 8 years (Fig.2), although in particular years some differences in length and age were noted. Results of investigations, carried out in the year 1964, are not comparable with the results from other years, since in this year trawls with 50 mm mesh in the codend were used in research fishing.

In 1963 and 1968 most of the cod measured were 36 to 68 cm (mean length 51.7 and 47.5 cm) and 4 to 8 years old.

In 1966, as in Div.2J there were rather large numbers of smaller fish. Most of the fish were from 33 to 65 cm and from 3 to 8 years of age.

In 1967 rather large individuals were noted. Most of them were from 33 to 77 cm (mean length 59.6 cm), although the range of the length from 51 to 71 cm and the age from 5 to 8 years comprised the largest number of fish.

From the data presented in Fig. 2 it appears that in 1966-1968 the 1961 and 1962 year-classes were of a great importance in the catches. Also the 1963 and 1964 year-classes seemed to be abundant.

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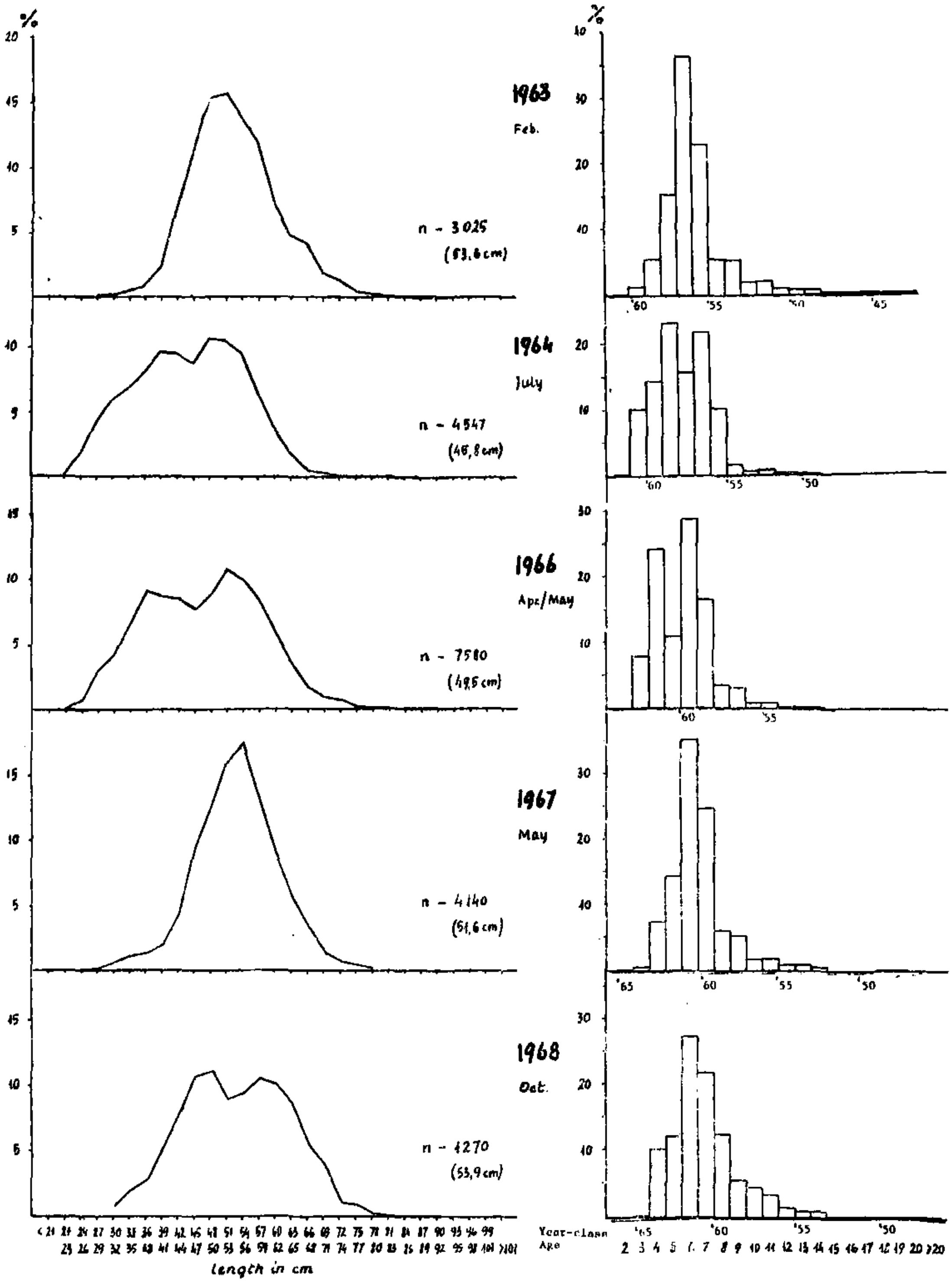

Fig. 1. Length and age composition of cod caught in Div.2J, 1963-1968.

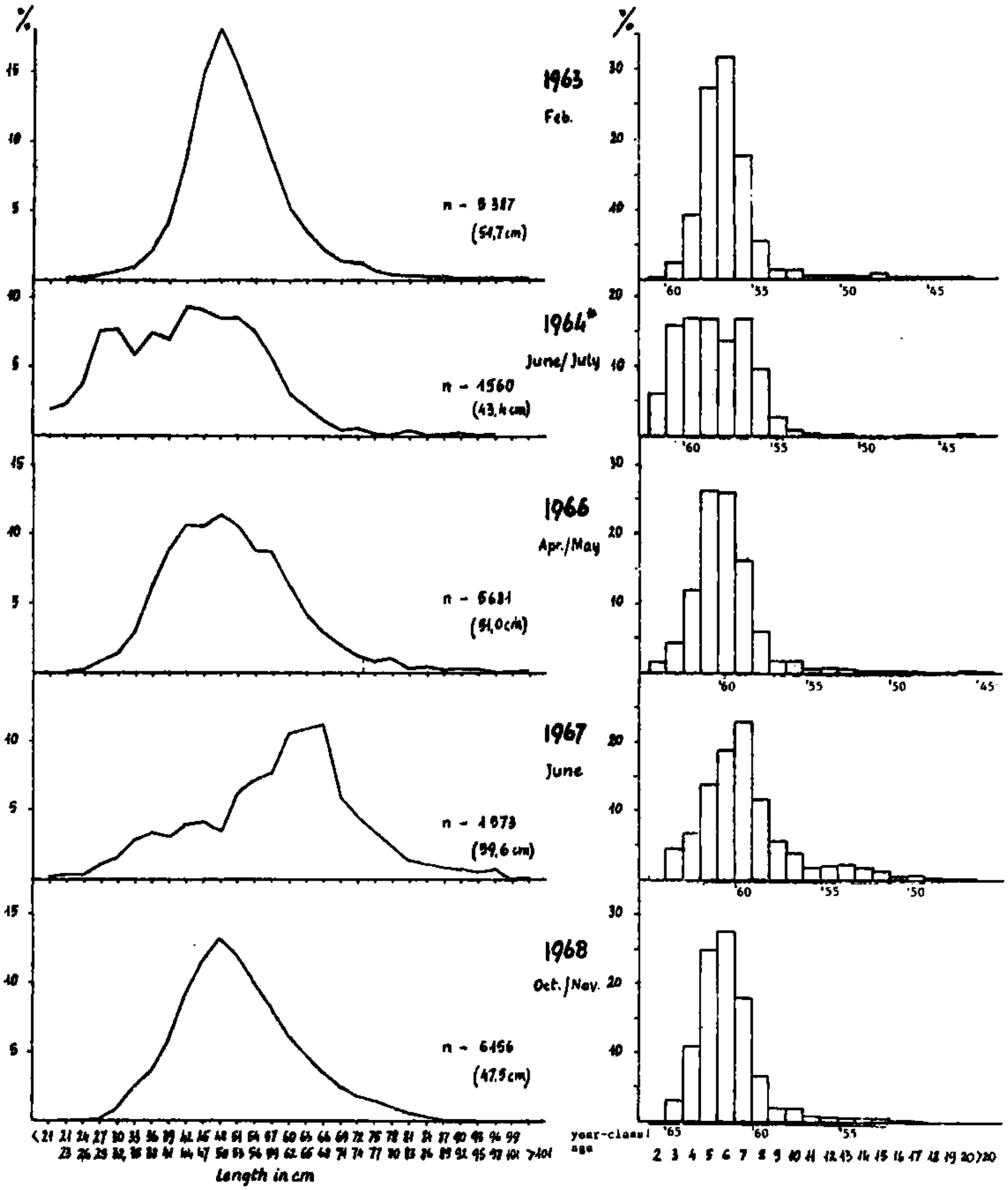

Fig. 2. Length and age composition of cod caught in Div.3K, 1963-1968.

2. On the possibility of assessing stock size and catch quota for Subarea 1 cod [1]

by Sv. Aa. Horsted
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Introduction

This paper is not intended to be more than a basis for discussion on the possibility of estimating present and future stock size by age-groups and future catch (eventually catch quota) of Subarea 1 cod. A work sheet for such calculations is proposed. However, this proposal may not be the only practicable approach to the problem. It is hoped, therefore, that the paper will initiate further studies on catch quota assessment.

Present knowledge and future work required on the biological aspect of catch quota management.

The fundamental knowledge necessary for setting a catch quota with any accuracy of practical interest consists of

(a) Complete, reliable and prompt statistics on catches, landings and effort.

(b) Adequate knowledge of age composition of catches by division, gear and quarter (or month).

(c) Current knowledge of parameters on growth and mortality including analysis of such parameters' dependence on changes in environment and stock density.

(d) Some broad knowledge of the strength of the pre-recruit cod year-classes. The closer these pre-recruit year-classes are to entering the fishery, the more accurate is the knowledge required.

Regarding (a) Statistics: The present quality of data seems sufficiently good although improvement could and should still be achieved. The speed with which data became available, mid May 1969, in this case has not allowed the author to make more than a rough calculation of the probable 1968 catch and a partly arbitrary assessment of the 1969 stock size and catch leaving for 1970, nothing more than a feeling of the trends in stock size changes.

If the Commission wishes to have reasonably accurate proposals for the following year's catch quota and some guidance on the

[1] submitted to the 1969 Annual Meeting of ICNAF as ICNAF Res.Doc.69/74

next 2 to 3 years' catch by June in any given year, it is obviously necessary to speed up the circulation of sampled data and statistics.

Regarding (b) Sampling: Although present knowledge of age composition of catches seems rather good, more intensive and especially better planned and co-ordinated sampling is required for the management of a quota system. Considering the great advances already made, it seems most likely, that an adequate international sampling routine can be achieved. Again, however, speedy analysis and exchange of data is required.

Regarding (c) Parameters: Knowledge of parameters is, of course, closely connected with items (a) and (b) above.

Regarding (d) Pre-recruits: Previous and present surveys on fish larvae and youngest age-groups of cod have provided some knowledge of the strength of the pre-recruit year-classes and enabled us to predict recruitment of "poor", "medium", "rather good", "strong", etc. year-classes and to predict upward and downward trends in stock size. For catch quota management this broad knowledge may not be sufficient. It will, therefore, be necessary to extend field work on pre-recruits; for example, by research vessels trawling with fine meshed trawls at selected stations each year at a certain time. Field work of this kind was started by Denmark in 1968. Preliminary results seem promising but cannot be fully evaluated before the present pre-recruits have been exploited for a few years.

In view of the above, the best possible way of handling the biological aspect of the catch quota management may be to form a working group for each regulated subarea. Such a working group would probably consist of one expert from each member country fishing in the subarea. If the group met in April each year national statistical offices and national fisheries laboratories should be able to provide data for the preceding year which their member of the working group could bring to the meeting. The findings of the working group could then be circulated in time to allow countries to study the report and to discuss the practical side of the catch quota management before and during the annual meeting.

Proposal for a model and a work sheet for stock size and catch quota assessment.

The work sheet for calculating stock size and catch shown in this paper bas been worked out and completed using the following procedure:

Annual landings by age-groups have been calculated from existing samples and statistics as mentioned by Horsted (1967a). These figures are given for the years 1962-67 in line 5 as numbers landed x 10^{-3}.

Using the annual value of F (Horsted, 1968) given in the uppermost heading of the sheet as applying to all age-groups and using, in this example, M=0.20 for all exploited age-groups, one can readily calculate the initial numbers present per year-class at the beginning of the year (t),

$$N_t = \frac{C_t}{\left(1-e^{-Z_t}\right) \cdot E_t}$$

This calculated value (in thousands) is shown in line 2 of the sheet.

The numbers of the respective year-class remaining at the beginning of the next year (t + 1) is then

$$N_{t+1} = N_t \cdot e^{-Z_t}$$

This figure is given in line 1.

In those years for which information on catch and stock composition exist (the latest year at present being 1967), N_{t+1} can, however, also be calculated in the same manner as just mentioned for N_t

$$N_{t+1} = \frac{C_{t+1}}{\left(1-e^{-Z_{t+1}}\right) E_{t+1}}$$, again given in line 2.

The initial numbers of the respective year-classes present is thus (for years up to and including 1967) arrived at in two ways, one figure (line 1) derived from observed catch and F in the past year, the other (line 2) from observed catch and estimated F in the year considered. These two figures should, with adequate sampling and statistics, be equal if all age-groups regarded were fully recruited and if our values of F and M applied to all age-groups in the respective years. The two values are, however, not equal. The ratio between them is given in line 3 and is also shown in a separate table at the bottom of the sheet. It will be noted that, while the accordance between line 1 and line 2 is extremely good for age-groups 7 and older, this is not the case for younger age-groups. In all cases younger age-groups are underestimated when the estimate is based on figures for the preceding year. The explanation for this may be a combination of the following possibilities:

(i) a considerable migration of small cod from Greenland coastal waters to offshore banks (Horsted 1967b) and in some years also from SE Greenland waters to West Greenland banks (e.g. Hansen, 1967; Meyer, 1965),

(ii) the slowest growing individuals of each year-class may not have reached the ℓc value when data for the calculation of the figures for line 1 were sampled but have when data for the figures for line 2 were sampled,

(iii) information (sampling) on discard and industrial fish is insufficient,

(iv) F and M have quite different values for the younger cod than those used in the calculations. Longlines, for example, tend to catch rather big fish although set in places where smaller fish are also known to be present (being caught by trawl or by hand line).

The ratio between the two figures (line 2 to line 1) is close to but in all cases less than one for age-groups 9 and older. This could probably be explained by the spawning migration of big cod from West Greenland waters to East Greenland - Iceland.

Some analyses of these theories should be made but lack of time and insufficient data have prevented this for the present meeting. In an attempt to estimate the 1968 and 1969 catch by a given overall value of F the author has nevertheless used the mean ratio values given at the bottom of the work sheet plus an arbitrary figure for recruits from the 1965 year-class which, from most recent surveys, seems a promising year-class.

Taking numbers present at the beginning of 1967 as given in line 2 and supposing F = 0.75 in 1967, (M = 0.20) the numbers present at the beginning of 1968 is readily calculated. These figures (line 1) are then multiplied by the mean ratio value thus giving initial exploitable stock in 1968 (line 4). The same procedure is then followed from 1968 to 1969 but of course with decreasing reliability in the result since the figure for age-group 4 is quite abitrary.

Supposing F = 0.80 in 1968 and 1969 and taking mean weight of the various age-groups from Horsted (1967a), the estimated 1968 catch is approximately 349,000 tons while the 1969 catch with present rather poor knowledge of pre-recruits is expected to be 293,000 tons only; the reason for the decline being the apparent relative poor recruitment in most recent years.

If one aimed at achieving a fishing mortality of F = 0.60 (corresponding to a 25% reduction in the estimated present effort) by means of a catch quota, the recommended 1968 quota would have been approximately 285,000 tons (possibly expressed as "not more than 300,000 tons") and the 1969 quota as "not more than 300,000 tons". A 25% reduction in effort in 1968 would thus have led to a 14-18% reduction in catch while already in 1969 (provided 25% effort reduction did occur in 1968) the stabilized reduced effort would mean a catch nearly equal to that which would have been taken by maintaining the estimated actual effort.

The uncertainty with which coming years' stock of youngest age-groups is set does not seem to be a serious matter as long as this stock is not greatly overestimated because it has been demonstrated (Anon., 1967) that the highest bio-mass in a year-class occurs at an age of 6-7 years. A quota which is set too low due to underestimated recruitment will thus be compensated by higher output in the following years.

It must also be born in mind that the introduction of a quota system could lead to some changes in the fishing operation, e.g. to concentrate the fishery in special seasons and hence on special age-groups thus giving another variation in F between age-groups than that presumed in the calculations here. Also the existence of more than one stock and possible density dependent changes in growth parameters and recruitment must be taken into account.

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SIMPLIFIED WORK SHEET FOR STOCK SIZE AND CATCH, SUBAREA 1 COD

Line 1: Numbers x 10^{-3} present at the beginning of the year according to preceding year's catch and F.
Line 2: Numbers x 10^{-3} present at the beginning of the year according to same year's catch and F.
Line 3: Relation 2÷1.
Line 4: Estimated numbers x 10^{-3} present at the beginning of the year based on figures in 1 and 3, the figure in 3 being mean of previous years.
Line 5: Numbers x 10^{-3} landed. 1962-67 based on samples and statistics, 1968-69 on estimated stock and assumed F.
A: Nominal catch (thousand metric tons) in Sta.Bull.
B: Nominal catch calculated from 5 and Table 2, Horsted, 1967.
+ including older year-classes.

Year-class	Line	Year 1962	1963	1964	1965	1966	1967	1968	1969	1968	1969
	F	.48	.54	.59	.65	.70	.75	.80	.80	.60	.60
1953	1										
	2	51605+									
	3										
	4										
	5	18078+									
1954	1		33627+								
	2	14772	32983+								
	3		0.98								
	4										
	5	5175	12590+								
1955	1		9965	22982+							
	2	19671	15187	21833+							
	3		1.52	0.95							
	4										
	5	6891	5797	8944+							
1956	1		40785	27317	23067+						
	2	80507	57257	28998	20444+						
	3		1.40	1.06	0.89						
	4										
	5	28203	21856	11879	8897+						
1957	1		137553	71500	29653	25045+					
	2	271522	149865	65344	38155	24209+					
	3		1.09	0.91	1.29	0.97					
	4										
	5	95118	57206	26768	16604	11205+					
1958	1		15493	32859	21178	9642	13534+				
	2	30555	68873	46669	22560	9076	12772+				
	3		4.45	1.42	1.07	0.94	0.94				
	4										
	5	10714	26290	19118	9818	4201	6188+				

Year-class	Year / F	1962	1963	1964	1965	1966	1967	1968	1969	1968	1969
		.48	.54	.59	.65	.70	.73	.80	.80	.60	.60
	1		2103	14455	14678	8900	5856	7732+			
	2		30297	32345	20824	14404	7222				
1959	3		14.39	2.24	1.42	1.62	1.23	0.94			
	4							7268+			
	5	1456	11565	13250	9062	6667	3499	3675+		3002+	
	1			8424	51391	53291	35210	19648	11420+		13947+
	2	A 451		113245	124687	86596	50810				
1960	3	B 435		13.44	2.42	1.62	1.44	1.21	0.94		
	4							23774	10735+		13110+
	5		6740	46391	54261	40081	24618	12020	5427+	9819	5414+
	1				4866	51627	47131	46834	22227		27145
	2		A 406		120793	115916	121113				
1961	3		B 345		24.82	2.25	2.57	1.29	1.21		
	4							60416	26895		32845
	5			4393	52566	53652	58680	30546	13598	24951	13565
	1					1076	6904	23954	14276		17435
	2			A 350		16980	61945				
1962	3			B 350		15.78	8.97	1.62	1.29		
	4							38805	18416		22491
	5				1096	7859	30013	19620	9311	16026	9289
	1						334	16467	24232		29594
	2				A 359		42583				
1963	3				B 367		127.49	4.07	1.62		
	4							65058	39256		47942
	5					380	20632	53308	19848	27203	19800
	1							2449	15416		18827
	2					A 366					
1964	3					B 352		17.11	4.07		
	4							41902	62743		76626
	5						3069	21186	31723	17306	31646
	1										
	2						A 419				
1965	3						B 411				
	4								60000		62000
	5							3000	30340	2500	25608
	1										
	2							B 349		B 205	
1966	3										
	4										
	5								3000		2500
									B 293		B 286

	Year	1963	1964	1965	1966	1967		
	age						mean	± s
	9	0.98	0.95	0.89	0.97	0.94	0.94	0.04
	8	1.52	1.06	1.29	0.94	1.23	1.21	0.22
Relation	7	1.40	0.91	1.07	1.62	1.44	1.29	0.29
2+1	6	1.09	1.42	1.42	1.62	2.57	1.62	0.56
	5	4.45	2.24	2.42	2.25	8.97	4.07	2.90
	4	14.39	13.44	24.82	15.78	(127.49)[x]	17.11	5.23

[x]not incl. in mean.

3. A yield per recruit function for Subarea 1 cod [1]

by Sv. Aa. Horsted and D.J. Garrod

Introduction

At its 1968 meeting the Subcommittee for Assessments prepared a review of the state of the fisheries in the ICNAF area, and, with regard to Subarea 1 cod, it was concluded that this stock is demonstrably overexploited (Redbook, part I, p.30, 1968). This conclusion was drawn from assessments summarized under Appendix 1, Annex 1 (p.44 of that Redbook) which were based on a constant parameter model using the parameters listed (M = 0.2) and assuming 'knife edge' recruitment at specified levels of ℓ_c/L. Taking the threshold ℓ_c = 35 cm indicated that yield per recruit would increase with up to 60% reduction in fishing mortality (F): the alternative calculation using ℓ_c 45 cm suggested that the level of F in 1965/66 (=0.6) was close to the optimum for the mesh size in use. In no case was the stock underexploited and the present situation was considered to lie within the range given. An alternative empirical analysis of the catch statistics for Subarea 1 cod also indicated the level of fishing to be close to the optimum and hence conformed more closely to the rigorous assessment using ℓ_c = 45 cm (Garrod 1968).

At its mid-term meeting in London in January 1969 the Subcommittee made provisional estimates of the catch quotas that should be set to achieve specified reductions in fishing mortality in 1969, though these were not related to stipulated management objectives. These quotas were based on calculations prepared by one of us (Horsted 1969). The form of these calculations provided further information on the pattern of recruitment to this fishery, and so permits the assumption of 'knife-edge' selection to be replaced by variation of fishing mortality with age. A yield per recruit curve has therefore been re-calculated to include this extra information in order to confirm the earlier conclusions of the Subcommittee.

The estimation of partial recruitment values

The working paper referred to calculating the numerical abundance of each age-group at the beginning of each year, using a defined value of F for all age-groups and years. For each age-group estimates were made in two ways:

(i) as the survivors from the stock in year x;

(ii) as the number of fish at the beginning of year x + 1 necessary to generate the catch observed in that year.

The difference between these estimates represents the number of new recruits (immigrants ?) entering the age-group x + 1, and the ratio between this and the number in the stock of a year-class at the beginning of year x

[1] submitted to the 1969 Annual Meeting of ICNAF as ICNAF Res.Doc.69/85

Table 1. New recruits per age-group as a proportion of the stock of the preceding age-group

Year Class	Calendar year 1963	1964	1965	1966	1967	Mean	Age-groups in ratio
1954	x						
1955	0.265	x					
1956	0.205	0.029	x				
1957	0.045	0.000	0.130	x			
1958	1.747	0.201	0.030	0.000	x	x	9/8
1959		0.590	0.190	0.264	0.095	0.104	8/7
1960			0.647	0.267	0.180	0.136	7/6
1961				0.532	0.638	0.268	6/5
1962					3.241	1.351	5/4

Negative ratios ${}_{r}N_{x+1}/N_x$ for age-groups 9/8 denoted x, and negative ratios for other age-groups are assumed to be zero.

Table 2. Estimates of recruitment to the exploited stock

Age	Partial recruitment (fishable proportion of each age-group)	Variation of F_{max} owing to partial recruitment
3	0.160	+
4	0.267	0.31
5	0.628	0.60
6	0.797	0.76
7	0.906	0.74
8	1.000	1.00

measures these new recruits as a proportion of the previous stock of that year-class. These proportions are shown for pairs of age-groups in Table 1.

The ratio for age-groups 9-8 is negative in all cases and could be interpreted in terms of emigration of older fish (to East Greenland and Iceland) or in terms of the variance of the estimates of mortality. It seems reasonable to assume from the ratios of 8-7 that recruitment is complete in the eighth year and from this the proportion of total recruitment can be computed for earlier ages. Thus, for example, if the ratio of new recruits at 8 (${}_rN_8$) to the stock of 7-year-olds, (N_7), ${}_rN_8/N_7$, = 0.104, and ${}_rN_8 + N_7$= 100, then N_7 + 0.104 N_7 = 100 and N_7 = 0.906. The estimated proportions of the total year-class recruited at each age-group are shown in Table 2, the value for 3-year-olds having been interpolated from the illustration of these results in Fig.1. They are underestimates to the extent that ${}_rN_x$ has not been corrected for natural mortality during the year prior to recruitment.

The original derivation of these stock estimates from a constant value of F for all age-groups within one year implies that all members of each age-group are equally available to the fishery. The new recruits must therefore be immigrating into the area of the fishery. However, by definition, population models should consider a 'unit stock' which would initially contain all potential recruits to the fishery, but at varying degrees of availability. That means that the size of a year-class is determined before recruitment, and its recruitment over a range of ages is expressed in variations of the catchability coefficient giving a proportion of F_{max}, the fishing mortality to which fully recruited age-groups are exposed. This approach to partial recruitment has been checked (Garrod, unpublished) by calculating variations of F with age from the same original catch data, using Gulland's modification of the 'virtual population' technique (Gulland 1965). The estimates so derived are compared with those estimated by assuming immigration of new recruits in Table 2.

In effect this comparison does no more than check the accuracy of the arithmetic, but it does illustrate the dual interpretation of the same figures, neither of which can be incorporated in the constant parameter model. Note however, that 50% recruitment occurs at about 5 years of age, corresponding to an ℓ_c of 50-60 cm. This seems absurdly high in terms of the size of fish caught: one would expect all cod over 50 cm to be available to all gears. However, we are considering variations of F with age and this is not only a function of size, but also of the concentration of fleets on particular parts of the stock. Thus, if immature and mature cod are intermingled in the autumn they will be subject to the same F in that part of the year; but if fleets concentrate on prespawning or spawning aggregations of mature fish earlier in the year, one may expect these older fish to suffer a higher mortality irrespective of their size in relation to a particular type of gear. The effectively high ℓ_c may therefore not be unrealistic.

Results

These estimates of fishing mortality, varied with age, have been incorporated in a population model which gives the variation in yield per recruit illustrated in Fig. 2. Taking the level of fishing mortality to have remained at $F = 0.6$, the same as in 1965/66 (the most recent years for which estimates are available at the time of writing), this calculation suggests that the upper limit of recruitment $\ell_c = 45$ cm used in the 1968 assessment was the more nearly correct. It appears that the level $F = 0.6$ is close to that giving the maximum sustained yield: it is equally true that some reduction in effort would not have an appreciable effect on the total yield, except for the immediate losses in the years immediately following regulations. The connotation that could attach to the phrase 'demonstrably overexploited' does seem to overstate the situation in this fishery as it was in 1966, especially since no evidence has been presented to show that fishing may have had a significant effect upon recruitment in this stock.

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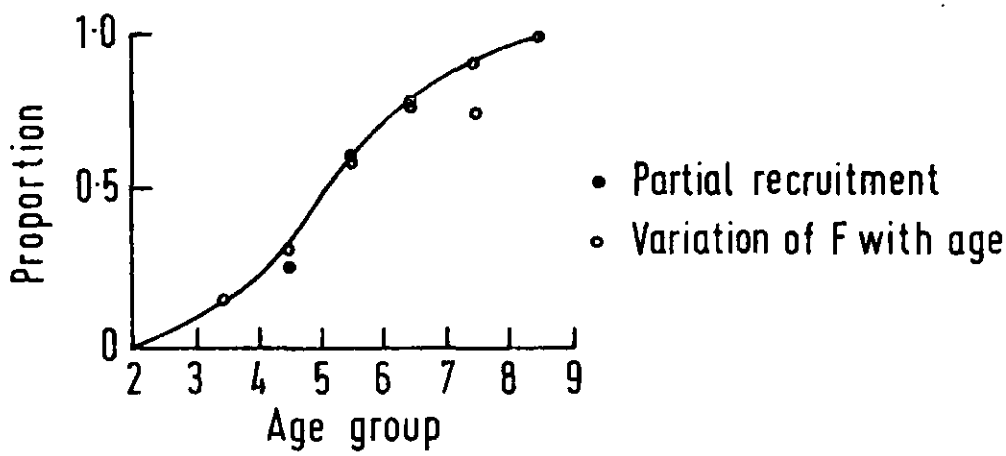

Fig. 1. Variations in recruitment on fishing mortality with age.

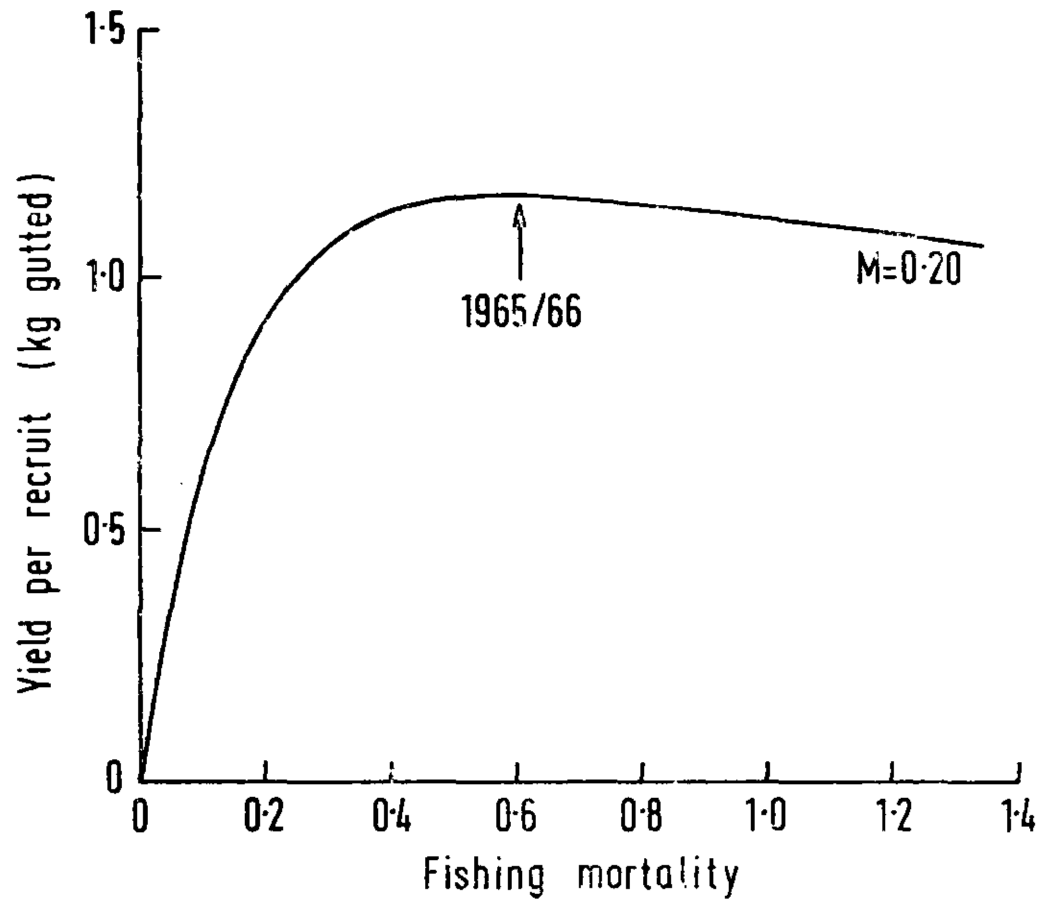

Fig. 2. Yield per recruit curve for Subarea 1 cod.

SECTION B
HERRING

4. Results of studies on herring from the region of Nova Scotia, Georges Bank and Statistical Subarea 6[1]

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In 1968 Polish vessels operated from Banquereau Bank in Subarea 4 to Cape Charles in statistical Subarea 6. Although the fishermen were primarily interested in herring catches they also caught other fishes. The catches of herring and other species in particular subareas are given in Table 1.

Table 1.

	Catch in metric tons			
Subarea	Herring	%	Other species	%
4	737	57.8	538	42.2
5	63,498	79.3	16,527	20.7
6	11,582	92.9	886	7.1
Total	75,817	80.9	17,951	19.1

These data show that most of herring were caught in Subarea 5, i.e. on Georges Bank, and that the percentage of herring in the catches increased as the fishing moved south.

Five types of vessels took part in the catches. The fish landed by these vessels and the fishing effort are given in Table 2.

Table 2.

	Catch in metric tons		No. hours	No. days
Type of vessel	Herring	Other species	fishing	fished
Factory-trawlers	5,457	967	876	153
Large freezer-trawlers	11,116	9,550	6,489	834
Smaller freezer-trawlers	3,620	1,657	3,474	301
Side motor trawlers	23,740	4,627	11,125	2,108
Steam side trawlers	31,884	1,150	28,322	3,215
All types of vessels together	75,817	17,951	50,286	6,611

Although the largest amount of herring was landed by steam trawlers, the importance of this type of vessel in Polish fisheries is gradually decreasing, whereas motor trawlers become more and more important. Hence the latter type has been accepted as a basis for determination of the standard fishing effort of the whole fishing fleet operating for herring.

[1] submitted to the 1969 Annual Meeting of ICNAF as ICNAF Res.Doc.69/57

Mean fishing yield and fishing effort were calculated on the basis of fishing results. These data, related to side motor trawler, as a standard unit, are given in Table 3.

Table 3.

Subarea	Catch of herring in metric tons	Fishing yield of a standard trawler in metric tons per day	The number of standard days fished
4	737	11.4	64.7
5	63,498	10.8	5,881.6
6	11,582	13.6	852.3
4-6	75,817	11.2	6,798.6

It appears from these data that with different fishing yield in particular subareas, 6,798.6 fishing days would be required to catch 75,817 tons of herring.

The length of herring

On the Nova Scotia fishing grounds 4,495 herring of length from 26 to 39 cm were measured in June and July. On Georges Bank 23,970 herring were measured in the period from June to September. The length ranged from 22.0 to 35.5 cm; mean length was 31.25 cm. In statistical Subarea 6 the measurements were performed in February and April. A total of 7,026 fish were measured. The range of their lengths was from 22 to 36 cm and the mean length was 30.08 cm. The results of these measurements are given in the form of curves in Fig. 1. The shape of the curves shows that the largest herring were present on the Nova Scotia fishing grounds. The curve representing the length of herring of this subarea has two peaks. The first peak includes fish of length 29.0 to 31.0 cm., the second 32.5 to 34.0 cm. The fish 29.0 to 35.0 cm long comprised 892.3‰ of the sample.

On Georges Bank herring were of medium length and the largest group among them (828.2‰) comprised fish 29.5 to 33.0 cm long.

The smallest herring were caught in Subarea 6. The most frequent lengths were 29.5 to 30 cm; they made up 690.3‰ of the sample. The descending slopes of the curves, corresponding to the most frequent fish lengths are almost parallel for herring caught on Georges Bank and herring caught in Subarea 6, but the distance between these slopes shows that the length increase between them amounted to about 0.5 cm (i.e. between the measurements performed in the periods February-April in Subarea 6 and June-September on Georges Bank). The parts of the curves, which correspond to the smallest herring, both in Subarea 6 and on Georges Bank, seem to show that only some of the smallest herring, which in the winter season occurred in the Subarea 6, migrated onto Georges Bank.

Age composition

The otoliths for age readings were taken simultaneously with fish measurements. The following number of otoliths were read in particular subareas: Nova Scotia - 300, Georges Bank - 2,150 and Subarea 6 - 1,000. Readings were performed according to the method of zone interpretation described by Chrzan and Draganik (Redbook 1968, Part III). Age composition is given in Fig. 2. Moreover, in order to stress the importance of particular age-groups in respect of weight and the number of fish caught by standard motor trawler per day the corresponding data have been given in Tables 4 and 5. The data from Table 5 may also be used for calculation of the fishing mortality of particular year-classes.

Both Fig. 2 and Tables 4 and 5 show that on the Nova Scotia fishing ground most of the fish belonged to the 1963 year-class. It made up 32% of the total weight of fish landed. The next was the 1960 year-class, comprising 19.7% of the catch. Also the 1959, 1958 and 1957 year-classes were comparatively abundant. The 4 oldest year-classes 1960-1957 totaled 47% of the landed mass of fish, whereas the 1961 year-class was rather poor, comprising only 8.2% of the catch.

The catch composition of herring on Georges Bank was different. As in previous years the 1960 year-class predominated, making up 40.7% of the catch in 1968. The next (20.2%) was the 1961 year-class, which was almost as abundant numerically as the 1963 year-class, though the latter was in third place in respect of weight (16.9%). On the whole there were considerably fewer older fish (9, 10 and 11 years old) on the Georges Bank fishing grounds than on the Nova Scotia fishing grounds.

In the Subarea 6, as on Georges Bank, the 1960 year-class was in first place making up 33.6% of the catch by weight. Next was the 1961 year-class - 25.3% by weight. Comparatively good abundance was noted in younger age-groups. It seems probable that the 1963 and 1964 year-classes may be of considerable importance in the catches on Georges Bank in 1969.

Figure 2 also gives the age composition of the spawning stock, based on the sample from Georges Bank taken in September. The 1960 and 1959 year-classes were dominant. In third place was the 1963 year-class, which was of rather average abundance.

Figure 3 shows the changes in length composition of particular year-classes caught on Georges Bank in the years 1965-1968. There may be noted a gradual shifting of the curves characterizing both the length of fish and the abundance of particular year-classes. First one notes that the 1960 year-class was predominant in these years. Most of the fish of this year-class were caught in 1966. In 1967 some decrease in this year-class was noted in the catches and a further decrease in 1968. The 1961 and 1963 year-classes which appeared with the 1960 year-class was, however, less abundant.

Table 4. The participation of particular age-groups (year-classes) in herring catches (in metric tons).

Subarea	Age								
	III 1965	IV 1964	V 1963	VI 1962	VII 1961	VIII 1960	IX 1959	X 1958	XI 1957
Nova Scotia	-	2.9	236.0	89.9	60.5	145.2	94.3	60.4	47.8
Georges Bank	381.0	2,349.3	10,731.1	6,921.3	12,826.5	25,843.7	3,682.9	635.2	127.0
Subarea 6	208.4	1,019.2	1,355.0	1,586.8	2.930.3	3,891.5	498.0	92.8	-

Table 5. The number of herring of particular age-groups (year-classes) in catch of a standard motor trawler per day.

Subarea	Age								
	III 1965	IV 1964	V 1963	VI 1962	VII 1961	VIII 1960	IX 1959	X 1958	XI 1957
Nova Scotia	-	253	17,376	5,274	2,775	7,238	4,520	2,688	2,200
Georges Bank	587	2,370	8,170	4,698	8,133	15,348	2,020	346	54
Subarea 6	2,307	9,894	9,850	9,743	16,817	20,836	2,400	390	-

Table 6. Mean length of male and female herring in particular age-groups caught in 1968 and parameters of the von Bertalanffy formula

Subarea	Sex	II	III	IV	V	VI	VII	VIII	IX	X	XI	L_∞	K	t_o
Nova Scotia	♂	-	-	27.9	29.4	31.6	31.9	32.9	33.8	33.9	34.5	36.1	0.266	-1.5
	♀	-	-	28.0	29.5	31.7	32.2	33.8	34.0	34.8	35.4			
Georges Bank	♂	17.9	24.2	27.2	29.5	30.7	31.5	32.3	33.2	34.0	34.5	35.3	0.305	-0.95
	♀	17.9	24.7	27.5	29.6	31.0	31.8	32.6	33.3	34.5	34.8			
Subarea 6	♂	-	23.5	26.0	28.3	30.3	31.0	31.9	33.3	34.5	-	38.4	0.188	-2.28
	♀	-	23.6	26.2	28.8	30.4	31.2	31.9	33.3	34.6	-			

Sexual maturity and feeding of herring

Observations on the stage of maturity of gonads and feeding of herring were carried out during research cruises. In February all the herring had gonads in the virgin and recovering stage (II). In April about 15% of fish on Georges Bank had gonads in the developing stage (III), whereas the rest of fish had gonads still in the recovering stage (II).

In the second half of June, during investigations carried out on the Nova Scotia fishing grounds the following stages of maturity were determined - in males: virgin and recovering spent about 3%, developing (III) - 45%, developed (IV) - 46% and gravid (V) - 6%; in females: virgin and recovering - 5%, developing - 63% and developed - 32%. Herring in these stages of maturity were feeding very intensively. About 92% had food in their stomachs, whereas only 8% were with empty stomachs. Mean degree of filling of stomachs was found in 40% of fish.

Observations carried out on Georges Bank showed that herring were maturing later there than in the region of Nova Scotia. In June the stages of maturity were: males - virgin and recovering about 10%, developing - 55% and developed - 35%; females: virgin and recovering - 10%, developing - 85% and developed - 5%. In July 45% of males and 70% of females had gonads in developing stage, while 40% of males and 20% of females had developed gonads. In August fish with developed gonads predominated, when simultaneously a considerable number of fish had gonads in gravid stage. There were hardly any fish encountered with gonads in the developing stage.

In July intensive feeding of herring was noted on Georges Bank. Stomachs most often contained the crustacean *Thysanoessa* sp. In August the concentrations of fish in the southern part of Georges Bank began to disperse. Except for fish still remaining in the northwestern regions, the feeding of herring became less intensive and the mean filling of stomachs was found in only 10% of fish in the samples. Towards the end of August most of fish had empty stomachs.

Rate of growth

As in 1966 and 1967 (Draganik and Zukowski, 1967) the rate of growth was determined from the mean length of particular age-groups. These lengths were calculated separately for males and females. The figures show that in the same age-groups in the three subareas the females were of slightly greater length (average 0.2 to 0.4 cm). The values of mean lengths in particular age-groups were used for the curves of growth of herring in the three subareas. The numerical data are given in Table 6 and the curves in Fig. 4. In addition to the von Bertalanffy equation for determination of the rate of growth, Gompertz's equation

$$l_t = ab^{ct}$$

was also used.

Also the parameters of this equation were calculated on the basis of mean lengths of herring, though the data related to herring caught in 1967. The values of these parameters were: a=37.0 cm, b=0.594, c=0.819. The 2 curves - one plotted according to the von Bertalanffy equation and another according to Gompertz's equation - are given in Fig. 5. The curves are almost identical for the older age-groups.

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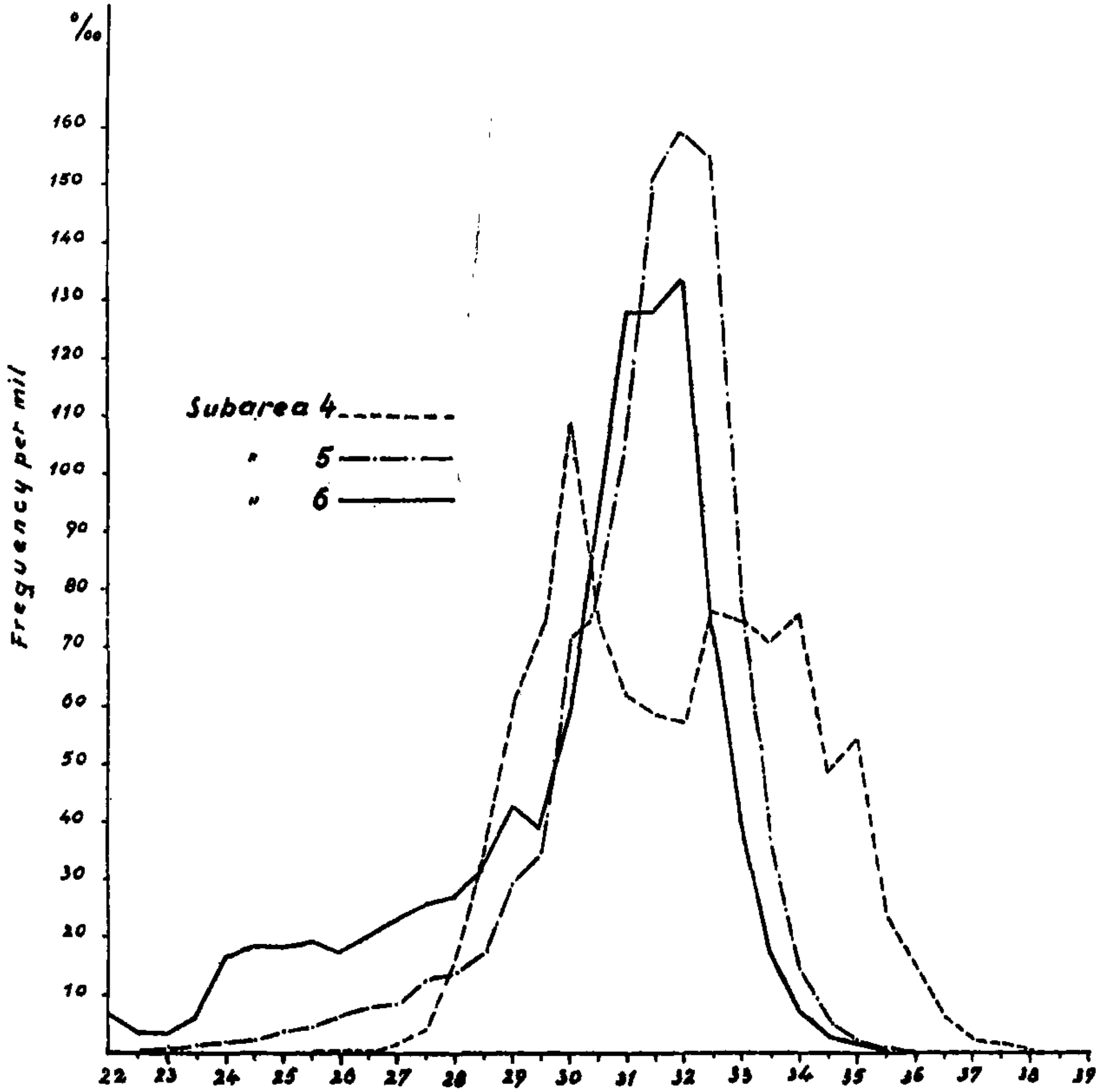

Fig. 1. Length composition of herring caught in Subareas 4, 5 and 6.

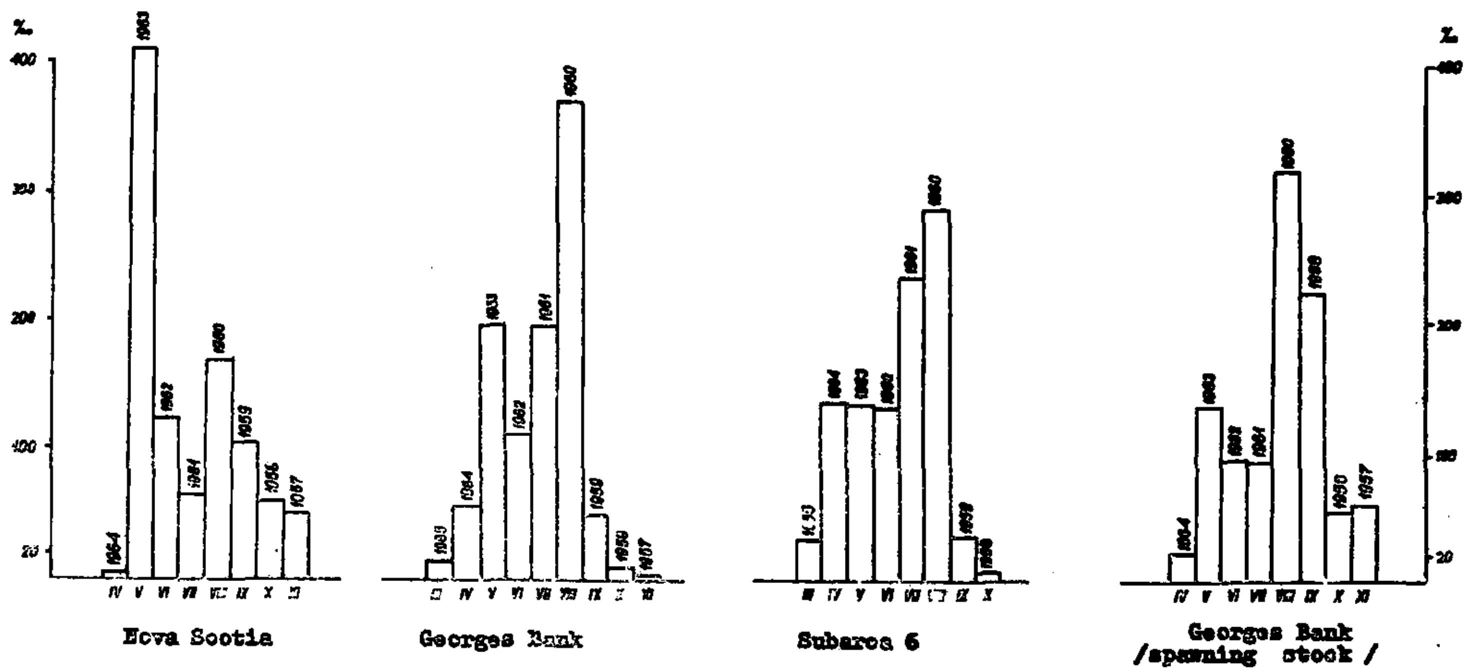

Fig. 2. Age composition of herring caught in 1968 in Subareas 4, 5 and 6.

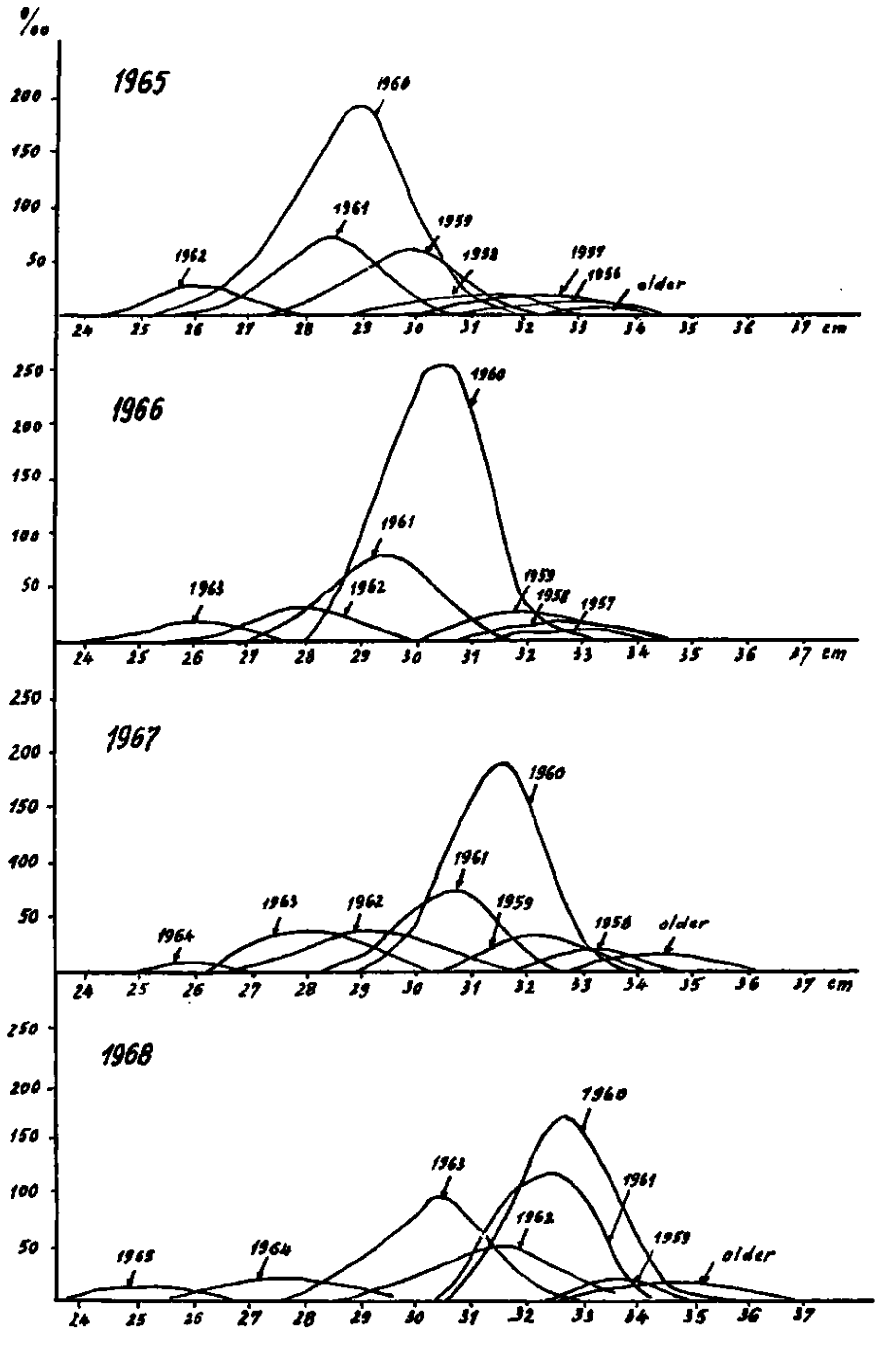

Fig. 3. Length frequencies of the year-classes of herring in the 1965, 1966, 1967 and 1968 catches.

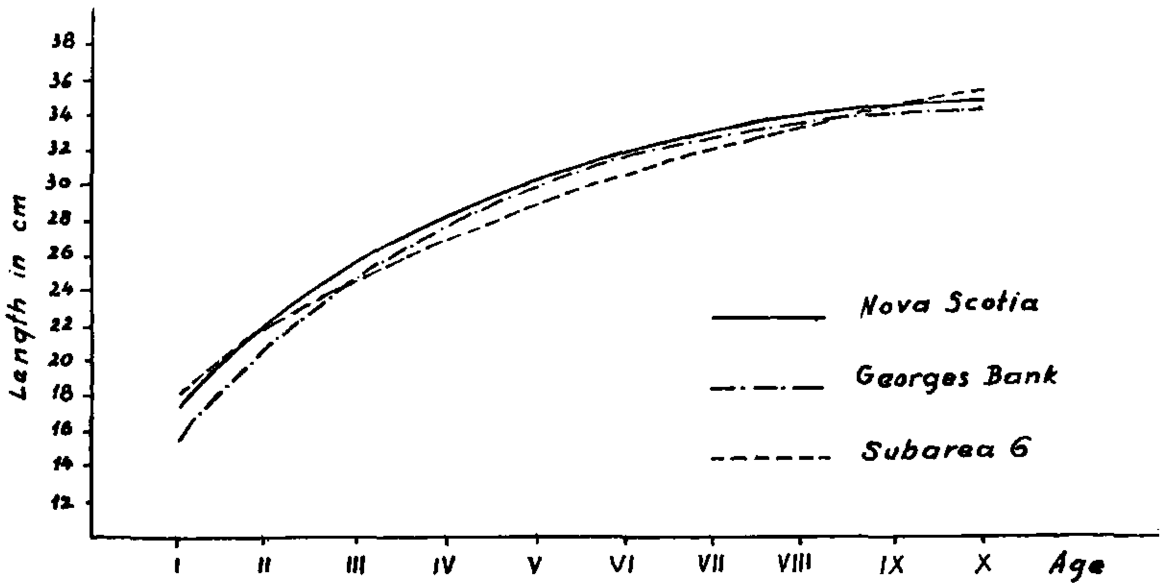

Fig. 4. Rate of growth of herring caught in Subareas 4, 5 and 6 in 1968.

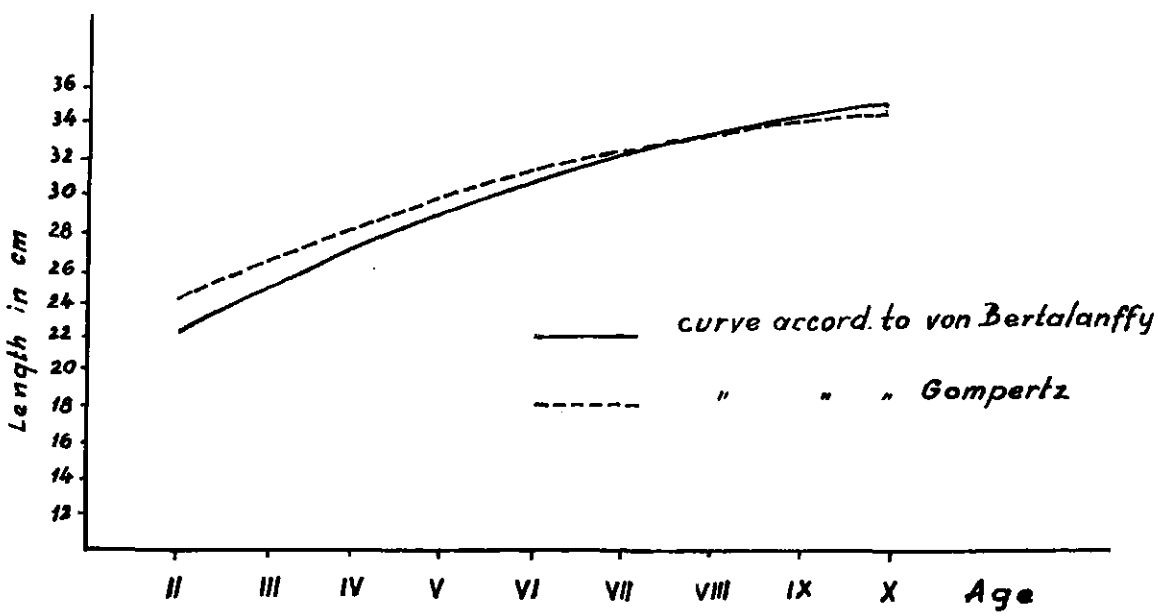

Fig. 5. Rate of growth of herring plotted according to formulas of von Bertalanffy and Gompertz.

5. A note on the fecundity of herring (*Clupea harengus harengus* L.) from Georges Bank, the Gulf of Maine and Nova Scotia [1]

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Introduction

The fecundity of herring (*Clupea harengus harengus* L.) has received considerable attention in Europe, (Hempel, 1964; Baxter, 1959; Polder and Zijlstra, 1959) but very little information on fecundity is available for the areas of Georges Bank, the Gulf of Maine and Nova Scotia (Barrett, 1968; Yudanov, 1966). This report presents egg counts from those three areas.

Materials and methods

Pairs of ovaries were collected in 1963 and 1964 from Georges Bank (208), the Gulf of Maine (205), and from Nova Scotia (243). The Gulf of Maine area extends along the coast from Grand Manan Island, New Brunswick, Canada to Cape Ann, Massachusetts; the Nova Scotia herring were collected from LaHave on the southeast coast to St. Mary's Bay on the west. Eggs for counting were prepared by first placing the ovaries in Gilson's fluid for a minimum of one week. The jars containing the ovaries and fluid were then placed in a small ultrasonic cleaning tank and subjected to high frequency (25 kc) sound waves for 15 or 20 minutes to separate the eggs from the ovarian tissue. The eggs were then washed of all foreign material and air-dried in a petri dish. After a period of 24 hours, eggs in both ovaries were counted.

Counts were made with a "Decca Master count".[2/] This machine consists of an integral feeder detector, and a master counter. Eggs were placed in a feeder bowl and were moved by vibration, singly, over a sizing groove where they fell through a detector aperture and past the photo-electric cell, which activated the counter. The sizing groove could be adjusted to allow various sizes of eggs to pass by the photo cell. Ten thousand herring eggs can be counted in 5 minutes with a 95% accuracy, (Boyer and Clifford, 1967).

All ovaries examined were in stage V of gonadal development except a very few late stage IV's from the Gulf of Maine. Stage IV refers to a full herring with the ovary taking up a predominant part of the abdominal cavity. The eggs are 0.5-0.8 mm in diameter. Stage V is a full herring with the whole abdominal cavity occupied by the ovary, and the eggs are from 0.8-1.0 mm or more in diameter.

1 submitted to the 1969 Annual Meeting of ICNAF as ICNAF Res.Doc.69/60

2/ Trade names referred to here do not imply endorsement of the commercial product.

The material presented here shows fecundity of the herring for Georges Bank, Gulf of Maine, and Nova Scotia. A more detailed analysis of the fecundity of the herring from these areas will be presented elsewhere.

Results

The data chosen for this analysis are given in Table 1. The counts of eggs plotted against length with the regression lines are shown in Fig. 1 to 3 for the three areas. Table 2 lists a comparison of egg counts.

Tests for differences were made by analysis of covariance and showed a significant difference in all instances, indicating that the fecundity levels were different and the relationships of fecundity to length were not parallel.

Table 1. Number of pairs of ovaries by year-classes examined for count of eggs from Georges Bank, Gulf of Maine and Nova Scotia, 1963-1964.

Year class	Georges Bank		Gulf of Maine		Nova Scotia	
	1963	1964	1963	1964	1963	1964
1960	-	104	-	41	-	9
1959	21	14	62	15	1	4
1958	49	7	50	15	71	19
1957	8	3	9	8	7	41
1956	1	-	3	2	11	11
1955	1	-	-	-	13	-
Earlier than 1955	-	-	-	-	35	21
Totals	80	128	124	81	138	105
	208		205		243	

Table 2. Comparison of egg counts of 1-cm groups of herring by area (X 1000) based on regression lines.

Total length (cm)	Areas		
	Georges Bank	Gulf of Maine	Nova Scotia
25	28.0	17.5	28.0
26	41.0	33.0	39.5
27	54.5	48.5	51.5
28	67.5	63.5	63.5
29	80.5	79.0	75.5
30	93.5	94.5	87.5
31	106.5	110.0	99.5
32	120.0	125.5	111.5
33	133.0	141.0	123.0

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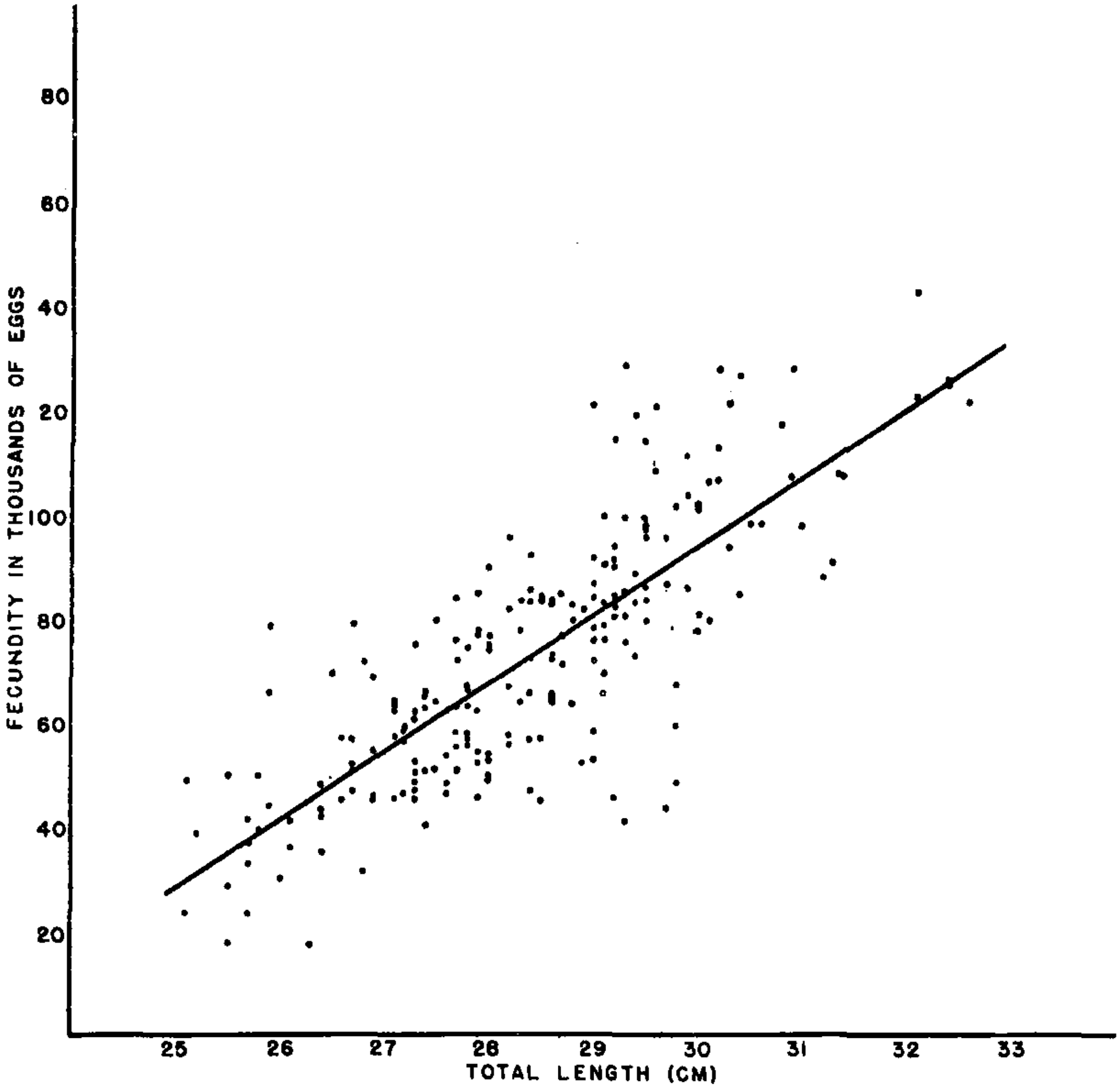

Fig. 1. Fecundity vs. total length (cm) from Georges Bank.

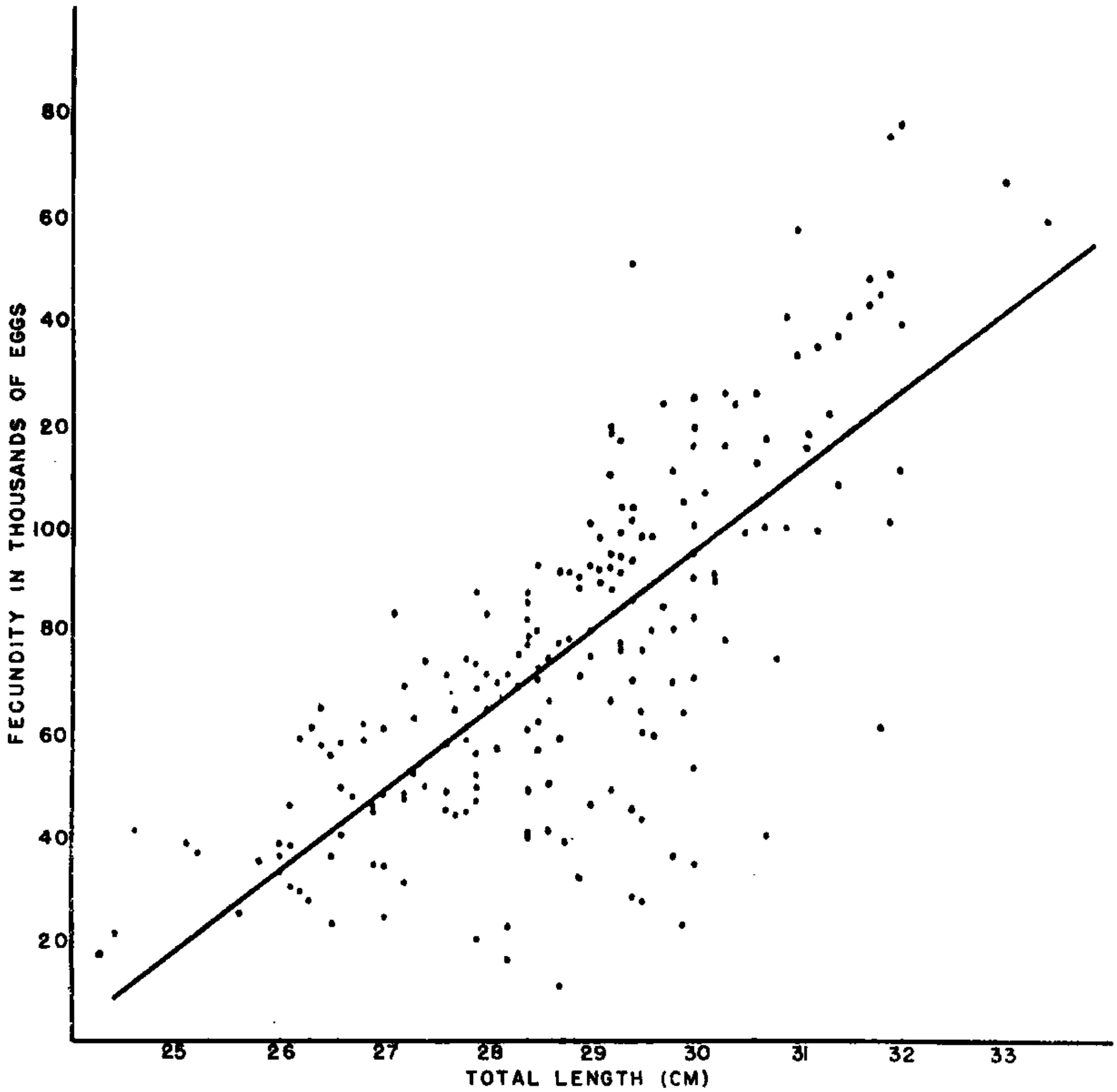

Fig. 2. Fecundity vs. total length (cm) from Gulf of Maine.

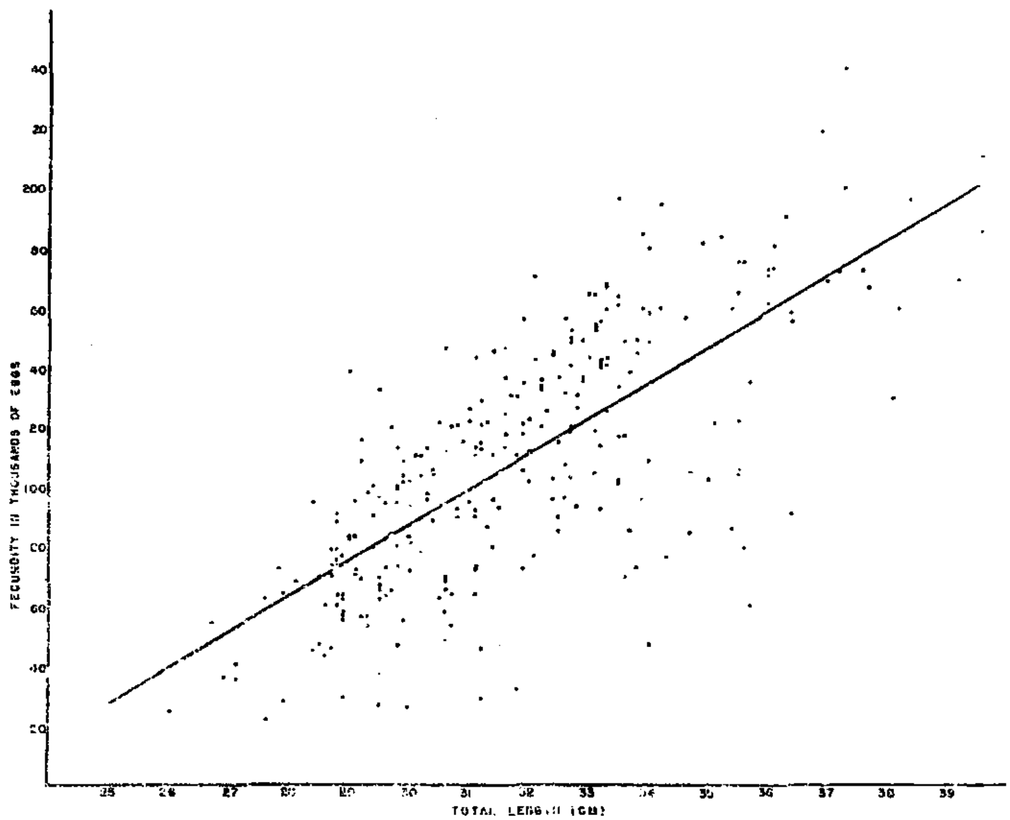

Fig. 3. Fecundity vs. total length (cm) from Nova Scotia.

SECTION C
OCEANOGRAPHY

6. Temperatures and salinities at Station 27 and in the St. John's-Flemish Cap section in 1968 [1]

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Station 27, 1968

At Station 27 off Cape Spear (Fig. 1), temperatures of the water column in late winter to spring and of the deep water in summer and autumn 1968 were higher and the surface and upper layer August-early winter temperatures lower than in 1967 (Templeman, 1968). They were also similar to those of 1966 (Templeman, 1967) except that in the latter year deep-water temperatures in summer and autumn were higher than in 1968.

Winter water-column temperatures and spring and summer bottom temperatures at Station 27 in 1968 were higher than and intermediate layer temperatures approximately the same as the average of 1950-62 (Templeman, 1965). The 1968 August-September surface temperatures were lower and the upper water layer late summer to autumn temperatures slightly higher than in 1950-62.

At Station 27, surface and upper water layer salinities in September-December were lower in 1968 than in 1967 (Templeman, 1968) and a little lower than in 1966 (Templeman, 1967). Also, at this Station the upper half of the water column in January had salinities in 1968 higher than in 1967 but similar to those in 1966. Otherwise salinities in the three years were not greatly different.

Temperatures St. John's to Flemish Cap section, summer 1968

In the section St. John's to Flemish Cap (Fig. 2), taken at the usual time in late July, average surface temperatures were lower than the average of the lowest surface temperatures at each station in the period 1950-67.

In this section also, temperatures in 1968 at the 20-30 m level were higher than average in the Avalon Channel and were close to the 1951-65 average at the remaining stations. Temperatures of the deep water of the Avalon Channel and bottom temperatures over the surface of the Grand Bank were higher than the average for 1951-65 period but not as high as the highest temperatures of the 1950-67 period and not as high as in 1966 but considerably higher than 1967. Temperatures in the cold-water offshore division of the Labrador Current on the eastern slope of the Grand Bank had a small central core, with temperatures of -1.5°C, as low as in any year of the 1950-67 period but the volume of very cold water was small and, on the

[1] submitted to the 1969 Annual Meeting of ICNAF as ICNAF Res.Doc.69/39

average, temperatures of this below $0^{\circ}C$ water were above the average for the 1951-65 period; a little higher than in 1967 but lower than in 1966. The temperatures of this eastern cold water body in 1968 were somewhat lower and the volume of below $0^{\circ}C$ water greater than in the warmest years of the 1950-67 period.

Temperatures in the deep water of Flemish Channel in 1968 were well above average and approximately as high as the highest encountered in 1950-67, while temperatures immediately above the top of the Cap and those on the seaward slope of the Cap were higher than any of this period.

The not unusual situation existed seaward of the Cap in that temperatures immediately on the eastern slope of the Cap were higher and accompanied by higher salinities than those farther seaward from the slope.

Temperatures St. John's to Flemish Cap section, winter-spring 1968

In an earlier St. John's Flemish Cap section taken on 29 February-6 March (Fig.3), surface-layer temperatures were naturally lower than in July, but in general, deeper water temperatures were not greatly different from those in July. Temperatures at the core of the eastern branch of the Labrador Current, at the second station seaward of Flemish Cap, and some of the temperatures of the deeper water of the Avalon Channel were higher and those immediately above the Cap lower than in July.

This section has been taken previously in the early part of the year, on 25-27 March 1961 (Templeman, 1962). On this occasion, temperatures above the western slope of Flemish Cap were higher but most other temperatures considerably lower than in Feburary-March 1968.

Salinities St. John's-Flemish Cap section, 1968

Apart from lower surface-layer salinities in July, there was little difference in the St. John's-Flemish Cap section in the general salinity picture between July and Feburary-March 1968, or between July 1968 and July 1967.

Acknowledgements

I am grateful to the scientists and technicians of the St.John's Station who have taken the routine temperatures and salinities at Station 27, especially to Messrs R. Wells and E. J. Sandeman, scientists-in-charge of the cruises on which the Flemish Cap sections were taken, also to Mr. A. G. Kelland, hydrographic technician at the St. John's Station.

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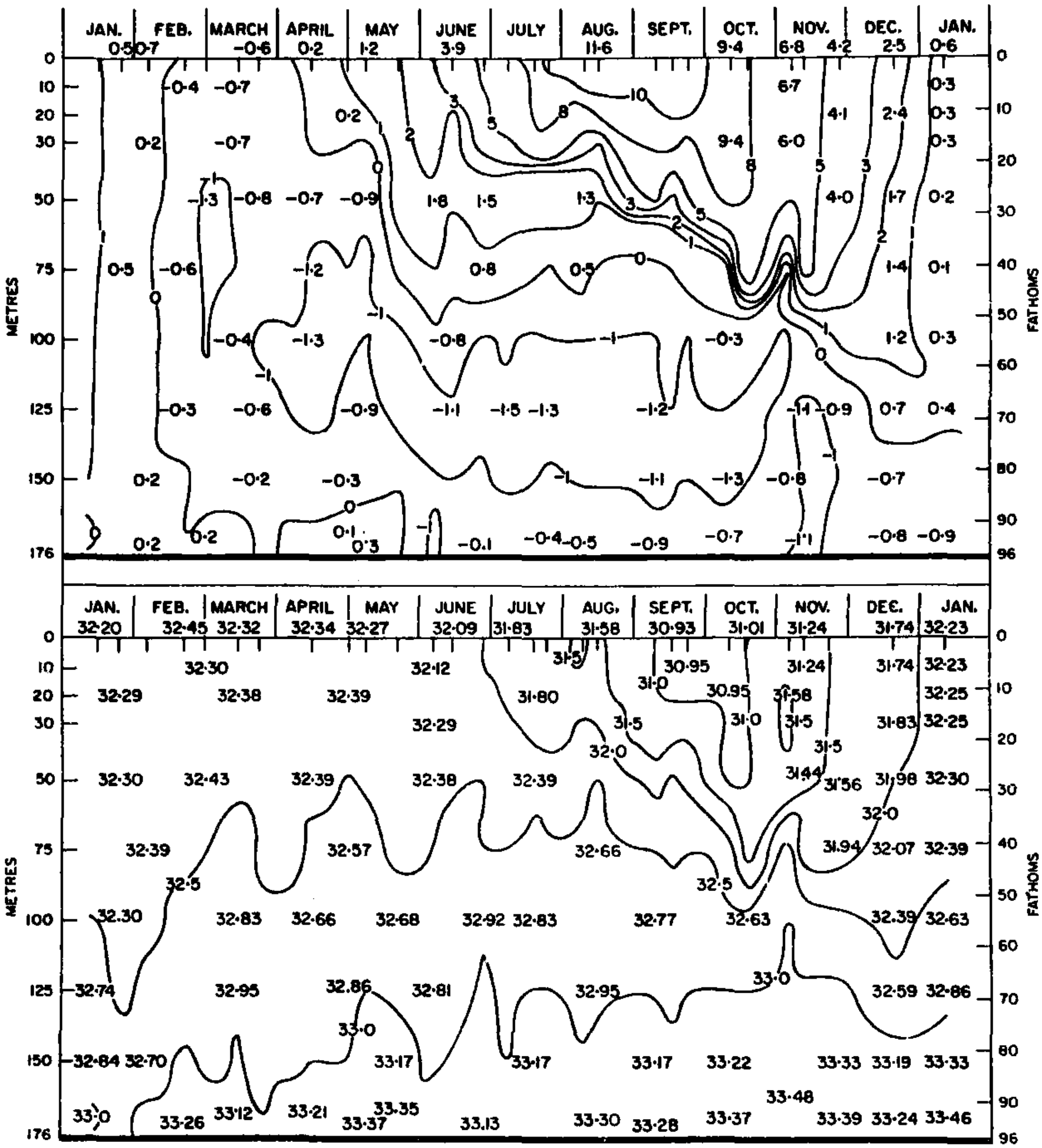

Fig. 1. Temperature (°C) above and salinity (‰) below, from surface to bottom, at Station 27 (see Fig. 2 insert), 2 nautical miles off Cape Spear near St. John's, January 1968 to January 1969.

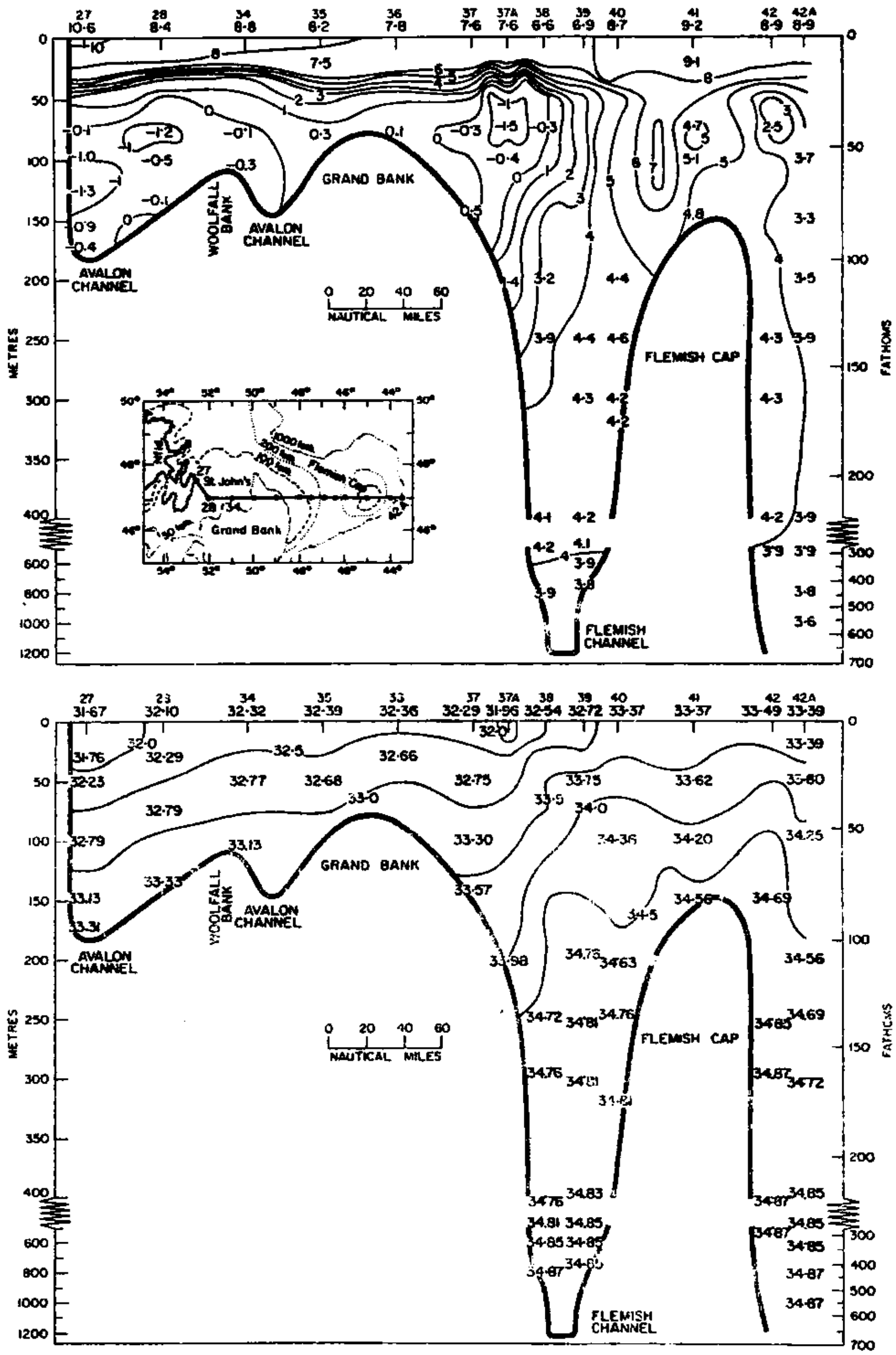

Fig. 2. Temperature (°C) above and salinity (‰) below, St. John's-Flemish Cap section, 25-27 July 1968.

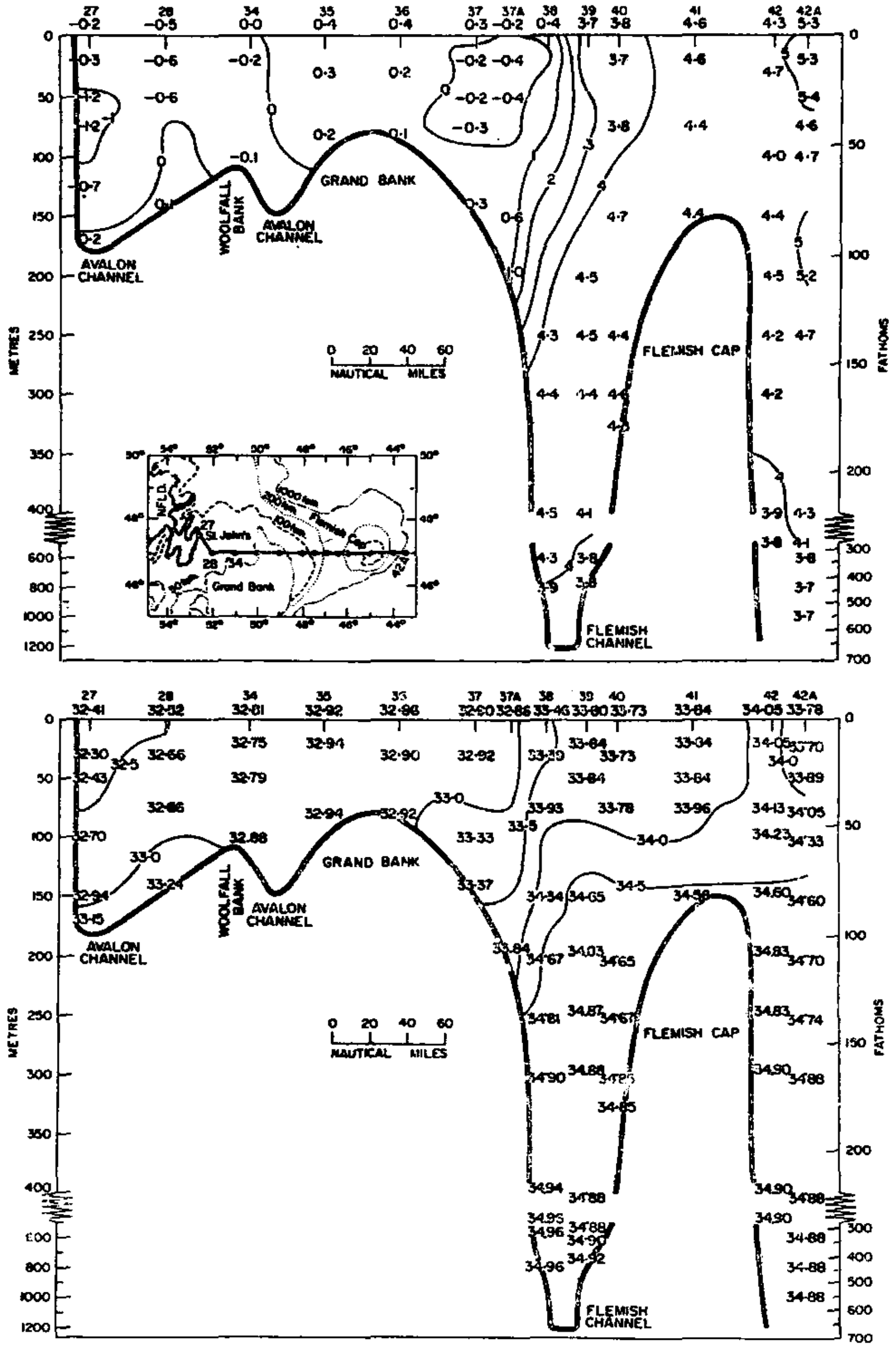

Fig. 3. Temperature (°C) and salinity (‰) below, St. John's-Flemish Cap section, 29 February-6 March 1968.

7. Annual variations in water temperature in the shelf area of Georges Bank and Nova Scotia in 1962-1968[1]

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Introduction

It is well known that the waters of the Northwestern Atlantic Shelf continue to be one of the most important areas for Soviet and foreign fisheries. From the beginning of fishing in 1962 on Georges Bank and the Scotian Shelf AtlantNIRO has carried out simultaneous investigations of the environment for fisheries. One of the significant characters of the environment is the water temperature, its year-to-year and seasonal variability. Since the 1950's a cooling trend has been observed in the area of Georges Bank, the Gulf of Maine and the Scotian Shelf (Lauzier, 1965a, 1967; Welch, 1967; Chase, 1967; Colton, 1967, 1968). However, this process has proceeded rather irregularly from year to year. Against a background of the cooling, both relatively warm and relatively cold years have been observed. This investigation deals with the variations in water temperature in the period between 1962 and 1968.

Material and Methods

Material for the investigation consisted of the data from the seasonal standard bathymetric surveys of the area which were made once a season annually and of the data from the bathythermographic stations made by ANIPPR vessels during the year when scouting for concentrations of commercial fishes. The available data on water temperatures allowed us to establish the locations in the area of shelf waters where observations might represent the temperature for the whole area. On the Scotian Shelf such locations are the Scotian Channel, Sambro Deep, Hally Passage and Cabot Strait. In the area of Georges Bank they are East Channel and Georges Basin Deep. In these locations, we may fix the advection of the warm Gulf Stream waters, the increase or decrease of which affects, first, the temperature of the off-bottom layer and, second, the temperature of the top intermediate water layer of Labrador origin (Briantsev, 1963). The degree of interaction of these two water masses play a significant role in determining temperatures which distinguish one year from another. The variability of the minimum temperature of the cold intermediate layer in the East Channel and Sambro Deep, the depth of the 5^{o} isotherm in the Sambro Deep (Fig.1) and the average off-bottom temperature of individual locations of Georges Bank and the Scotian Shelf (Fig. 2, 3) were taken as indices of annual temperature conditions. The off-bottom temperature for each location given in Fig. 2 and 3 was the average for a square of 30' longitude by 20' latitude. Due to the lack of observational data, one or two neighbouring

[1] submitted to the 1969 Annual Meeting of ICNAF as ICNAF Res.Doc.69/53.

squares were added to some selected squares provided that the depth of the whole area was not changed significantly. In addition the temperature data for standard sections and surveys were used to compare similar seasons.

Results of observations

The results of observations on the Scotian Shelf show that, during the 1962-1966 period the highest temperatures were recorded in 1962-1963. After 1963 temperatures decreased in the whole layer in all seasons as compared with the two previous years. The cooling tendency was established as early as the end of 1963. In the winter of 1964 the off-bottom temperature was the lowest (3.5°C) during the 1962-1965 period. In other seasons of 1964, although the temperature had increased by several tenths of a degree it was still the lowest.

Table 1 shows the variability of the mean temperature of the 100 m bottom layer for Sambro Deep (Halifax Section). The index was lower in all seasons of 1964 than in the two previous years.

Table 1. Mean Temperature (C°) of 100 m-bottom layer Sambro Deep, Halifax Section.

Seasons \ Years	1961	1962	1963	1964	1965	1966	1967	1968
Winter	4.5	5.5	6.0	3.5	5.5	3.2	5.1	6.3
Spring	4.5	5.5	5.6	4.0	4.0	3.5	4.8	8.1
Summer	4.5	6.0	5.7	4.0	4.0	3.6	6.3	7.7
Autumn	5.0	5.5	5.5	4.8	4.5	4.5	6.5	8.1
Mean	4.6	5.6	5.9	4.0	4.5	3.7	5.7	7.6

The variability of the average depth of the 5°C isotherm for Sambro Deep also shows that the volume of the warm bottom water-mass was significantly less in almost all the seasons than in corresponding seasons of previous years (Fig.1b). According to other data (Lauzier, 1965b), the superficial temperature at the coastal stations (ICNAF Div. 4X, 4V, 4W) in 1964 was the lowest since 1948. Temperature increased slowly till spring 1965. Since then it has decreased almost to the 1964 level, that is, 1965 was nearly as cold as 1964. The development during 1961-1968 is well illustrated by the variation in depth of the 5°C isotherm and by the variation of minimum temperature in the cold intermediate layer. In 1965 the volume of warm water increased somewhat, however, it was closer to that for 1964 than that for 1962 and 1963. Fluctuations of the minimum temperatures in the cold intermediate layer correspond to the variation in average depth of the 5°C isotherm.

In 1963 the minimum temperature of the intermediate layer was 3°, and in 1964-1965 it decreased to 0.5°. Cooling was observed also in the area of Georges Bank after 1963. On the Scotian Shelf, cooling appeared with the increased advection of cold Labrador waters which had spread along the northeastern, eastern and southeastern slopes of the bank. Thus, in the East Channel, the minimum temperature was an average of 2°C lower in 1964 than in 1963. The results of surveys made at the end of spring of 1963 and 1964 over the southeastern slopes of Georges Bank showed that off-bottom water temperature decreased by 3° - 5°C in 1964. In summer of 1965 the minimum temperature of intermediate layer was 1° lower than in 1964 in the area of northern slopes. In the locations adjacent to the northwestern slopes of the bank, cold water of the intermediate layer spread to the bottom in summer of 1965. It was greater in volume and lower in temperature by 1°C from that of the summer of 1964. During the summer the off-bottom water temperature of the southeastern slopes was 5° - 8°, that is, it was the same as in 1964, and on the southern locations it was 1°C lower.

Temperature observations in 1966 showed that the process of cooling continued. In winter and spring of 1966 this index was considerably lower than that for the same periods of 1965. According to the results of hydrographic surveys in the area of the Scotian Shelf made on 6-10 and 22-25 February as well as on 3-6 and 7-10 March of 1966, the off-bottom temperature of the Scotian Gulf was 1.3° lower than in 1965. The data from the Halifax Section which was occupied 5 times during the winter and spring showed that the off-bottom temperature did not reach 5°C during this interval, although this value was observed annually for 5 previous years. According to the data on other sections made on the Scotian Shelf, the off-bottom temperature was also lower than 5°C. In the winter the difference in the average value of the off-bottom temperature of Sambro Deep was 2.3°, in spring it was 0.5°, in summer it was 3°, and in autumn the index was the same for both years.

The temperature difference in the area of Georges Bank in 1966 as compared with 1965 consisted of a shift in the time of the spring warming and of a warm water advection weakening into the slope locations. In addition, in summer of 1966 a cold intermediate layer was observed in all sections crossing the bank and US Shelf to the vicinity of Long Island at 30-75 m in the south and between 45 and 180 m in the north. The temperature of this layer did not change significantly in a westward direction and was 2° to 2.5° lower than the level of 1965. Thus, 1966 was colder by the thermic background than 1965 and colder than 1964 by some indices.

The 1967 winter observations in the area of Georges Bank showed that the temperature was much higher than in 1966. On the section along the East Channel (Fig. 4) the temperature in water column was 1° higher and on the section along 70°W, it was 4° - 6° higher. Temperature conditions in the water masses of the central and eastern parts of the banks were similar to those for 1965.

On the Scotian Shelf, cooling was weaker in 1967 than in 1966, and the temperature of surface layer was 2^{o} - 2.5^{o} higher than in 1965-1966. Such an increase was mainly due to the intensive inflow of Gulf Stream water into the East Channel, the Scotian Gulf and Cabot Strait. In the Halifax section, the off-bottom temperature in Sambro Deep was $1^{o}C$ higher, and the temperature of the whole layer was on the average 3^{o} - $5^{o}C$ higher. In Cabot Strait, the surface and bottom temperatures were $2^{o}C$ higher. The shallow parts of Georges Bank area and particularly those of the Scotian Shelf cooled to a lesser extent in the first half of 1967 than in 1965, and parts with depths of 100-200 m in the whole area were constantly affected by the advection of warm Gulf Stream water, the temperature of which was $14^{o}C$ in the west and $6^{o}C$ in the east. In the spring of 1967 the advection zone expanded and reached the sectors with depths of 50-70 m in May. The period of spring temperatures was, on the whole, close to the 1965 level with the exception of April which was similar to the cold April of 1966.

In the summer of 1967, warming was noted not only in the bottom waters of the Scotian Shelf, but also in the surface water mass. The surface waters of a considerable part of the Shelf, with the exception of the shallow areas of Browns, Roseway and La Have and Sable Island Banks, had temperatures of 2^{o} - 3^{o} higher than in 1966. Observations in Halifax section showed a temperature increase of 1^{o} in the nucleus of Labrador waters and of 2^{o} - 3^{o} in the off-bottom layer.

In the section through Cabot Strait joining St. Pierre and Banquereau Banks, the August surface temperature was 5^{o} higher than in 1965, and the subsurface temperature due to the advection of Gulf Stream waters had temperatures of 6.1^{o} - 7.5^{o} in the nucleus (Fig. 9).

In the area of Georges Bank, in contrast to the summer of 1966, there was a stronger inflow of Gulf Stream water into the deep part of the Gulf of Maine through the East Channel where the nucleus of the cold intermediate layer either was not observed in the normal temperature range or it was noted to be in a rather converted form.

In the autumn of 1967 (November) intermediate and especially off-bottom temperatures of deep waters continued the same as in August and in some cases it was even higher than in August. Apparently, the inflow of Gulf Stream water in the August-November period did not weaken and it continued to be at least at the same level as in August. Therefore, the warming in the Georges Bank and the Scotian Shelf areas in 1967 which was the most striking in the first half of the year, spread over the whole zone with the exception of a narrow coastal belt inside 50 m isobath and of the shallow parts of the Scotian banks.

In 1968 the advection of Gulf Stream waters onto the shelf increased. Compared to the 1967 conditions, temperatures of the 100 m - bottom layer were 0.5^{o} - $1.0^{o}C$ higher in the East Channel, 0.5^{o} higher in the Scotian Channel, 2^{o} - 3^{o} higher in Cabot Strait (Figs. 4, 6, 8). The minimum temperature of the cold intermediate layer (Halifax section) was also higher than in 1966 and 1967. In the spring the lowest value over the period 1962-1968 was 0.9°C in 1966, 1.8°C in 1967 and 3.1°C in 1968. In Sambro Deep the volume of warm water as shown by the depth of the 5°C isotherm was maximum in spring of 1968 over the period 1961-1968. During the spring the areas of shelf with the depth up to 75 m continued to be influenced by the warm water advection as a result of which the maximum temperature of bottom waters reached 8.5°C in Sambro Deep, 9.9°C in the East Channel, 8.9°C in Cabot Strait, 5.7°C in the deepwater part of Gulf of Maine. Data from summer-autumn surveys (two in July, one in August and one in October) showed that during the summer and autumn the Gulf Stream waters went out by a wide front into the southern slopes of the shelf extending to the shallows with depths of 60-70 m. Their inflow through the East Channel increased in October and spread not only into the deeps to the north of Georges Bank, but also went out of their limits. Figures 5, 7 and 9 present the summer-autumn conditions in the section through the East Channel, in the Halifax section and in the section along Cabot Strait. They show the advection of waters into the deep-water parts of the shelf. Thus, the analysis of seasonal temperature data shows a powerful and long advection of Gulf Stream water onto the area of Georges Bank and the Scotian Shelf that mainly provided higher temperatures in the water masses in 1968 than in 1966 and 1967.

Thus the period 1962-1968 has the following temperature characteristics:

1962 and 1963	-	relatively warm years;
1964, 1965 and 1966	-	relatively cold years;
1967 and 1968	-	relatively warm years.

Over the above-mentioned period the warmest years were 1963 and 1968, and the coldest were 1964 and 1966.

Discussion

The temperature history of the waters of the area investigated is undoubtedly very important and its variation one way or the other may influence directly or indirectly some of the biological processes. In particular, the decrease in abundance of silver hake (*Merluccius bilinearis*) in the area of Georges Bank may be attributed, with other causes, to the cooling which has been observed since the 1950's and especially remarkable in 1962-1963. As the indices for the determination of yearly thermic background we may use the very different thermic characters of water masses depending on the specificity of the area, on the number and frequency of observations, and on the amount of space covered by these observations.

Since it is impossible to make observations over a large area with sufficient frequency at present, it is necessary to select representative sectors of the shelf. Observations on these sectors, even if casual, help to single out the temperature of waters in the area and to trace its year-to-year and seasonal variability.'

As mentioned above, the East Channel, Georges Basin Deep, the Scotian Gulf (Sambro Deep) and Cabot Strait should be added to the present sectors in the area of Georges Bank and the Scotian Shelf.

Analysis in incidental observations showed agreement between the variation of the minimum temperature of the cold intermediate layer and the depth of 5°C isotherm for the two above-mentioned sectors. In addition, there is agreement with the year-to-year temperature trend. V.A. Briantsev has proposed, as a temperature index, the average temperature at the 100 m level at especially selected representative points on the standard sections in the area of Georges Bank and the Scotian Shelf.

Summary

Results from data collected by AtlantNIRO research and scouting vessels give the variations of water temperature in the shelf area of Georges Bank and the Scotian Shelf in 1962-1968. The increase or decrease of advection of warm Gulf Stream waters and of cool waters of Labrador origin onto the shelf plays the leading role in the formation of these variations. Seasonal variability of average temperature for the 100 m bottom layer the minimum temperature of the intermediate cold layer, the depth of the 5°C isotherm as well as the average temperature of the off-bottom layer in the individual locations of the area of Georges Bank and Nova Scotian Shelf were taken as the indices of thermic background. From the investigations it is concluded that, for the period 1962 to 1968, the relatively cold years are 1964, 1965, 1966 and the relatively warm ones are 1962, 1963, 1967 and 1968.

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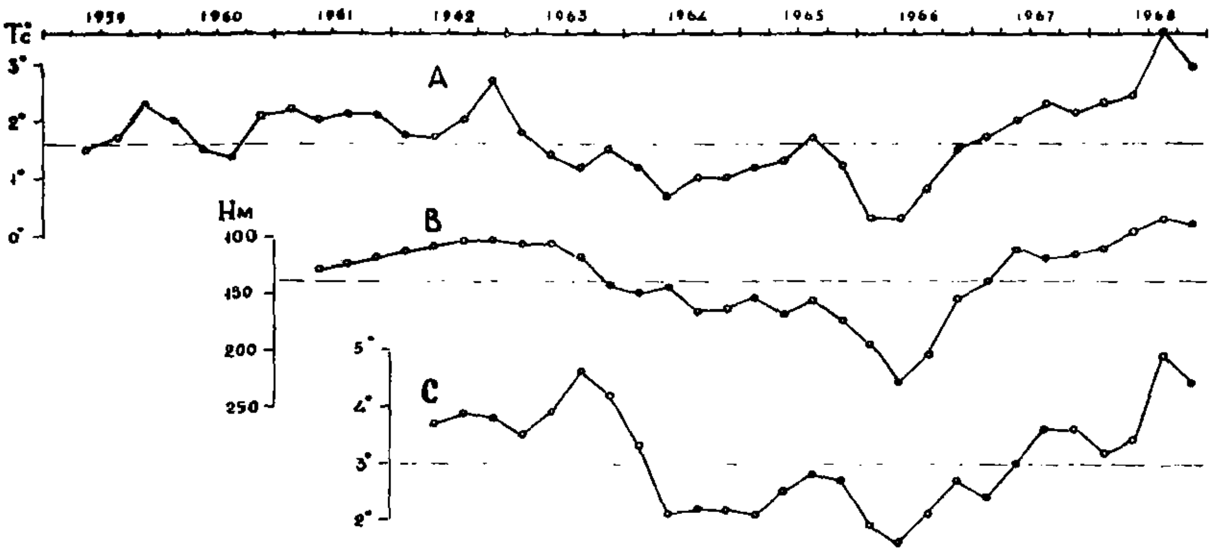

Fig. 1. A. Seasonal variability of minimum temperature in the nucleus of cold intermediate layer, Sambro Deep;
B. Seasonal variability of average depth of 5°C isotherm, Sambro Deep;
C. Seasonal variability of minimum temperature in the nucleus of cold intermediate layer, East Channel. Dotted lines represent mean values of the characters for the period of observations.

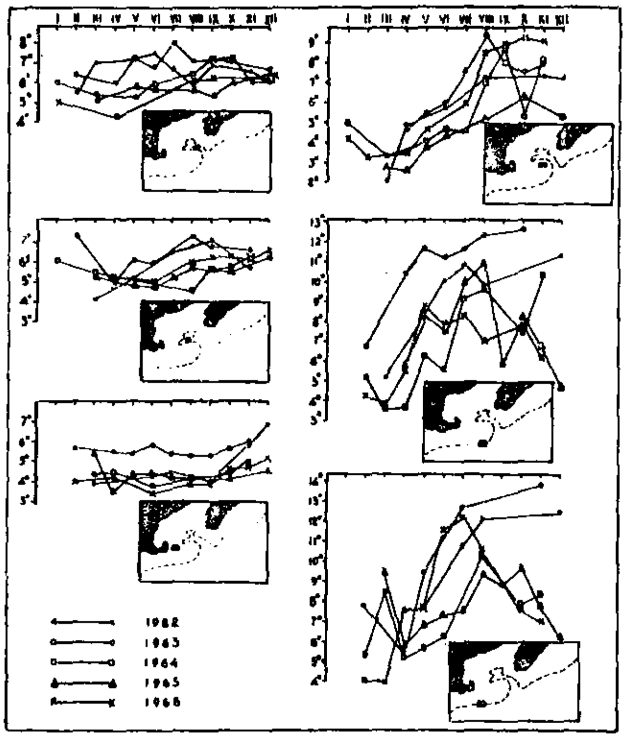

Fig. 2. Average temperature of off-bottom water layer on some sectors of the area of Georges Bank in 1962-1966.

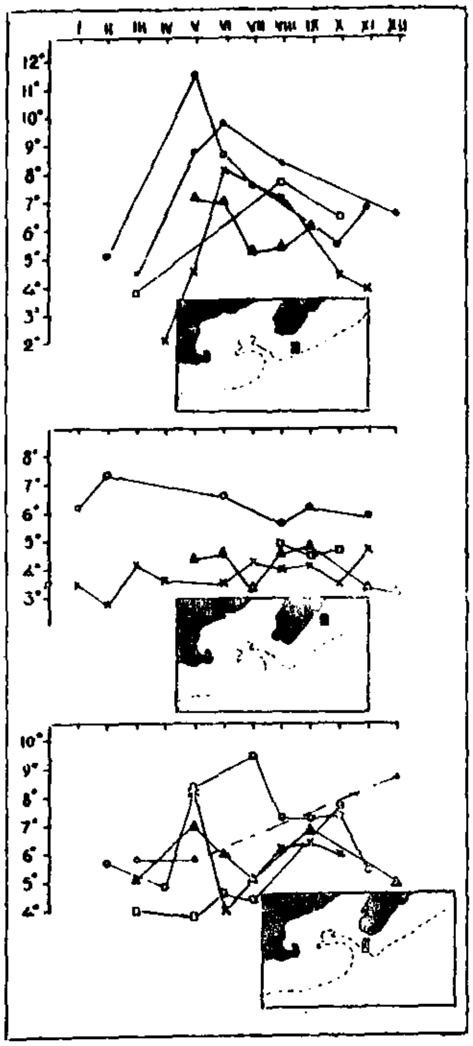

Fig. 3. Average temperature of off-bottom water layer on some sectors of the area of the Scotian Shelf.

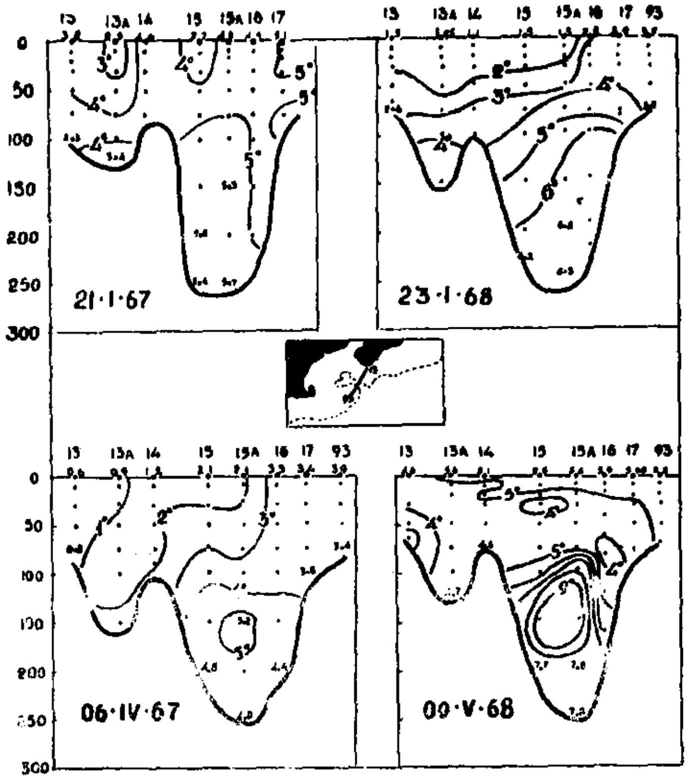

Fig. 4. Water temperatures in the section through the East Channel in winter and spring of 1967 and 1968.

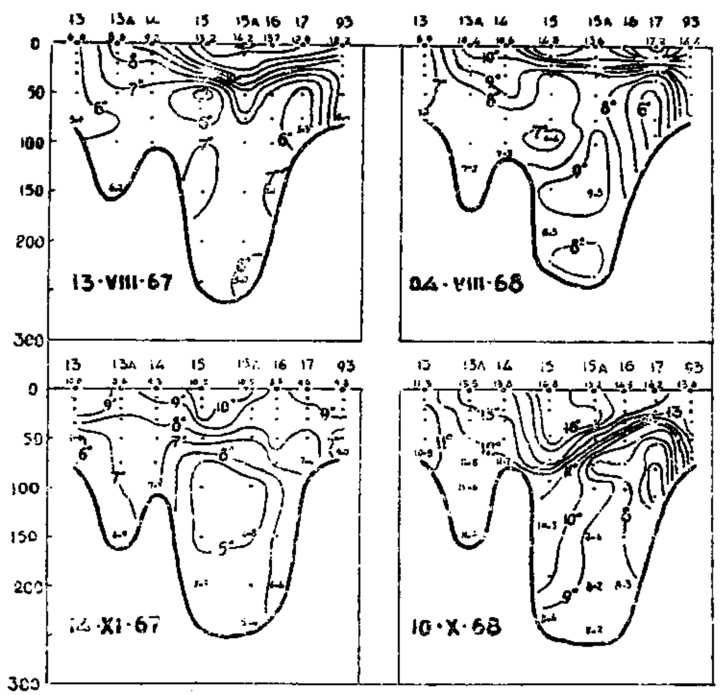

Fig. 5. Water temperatures in the section through the East Channel in summer and autumn of 1967 and 1968.

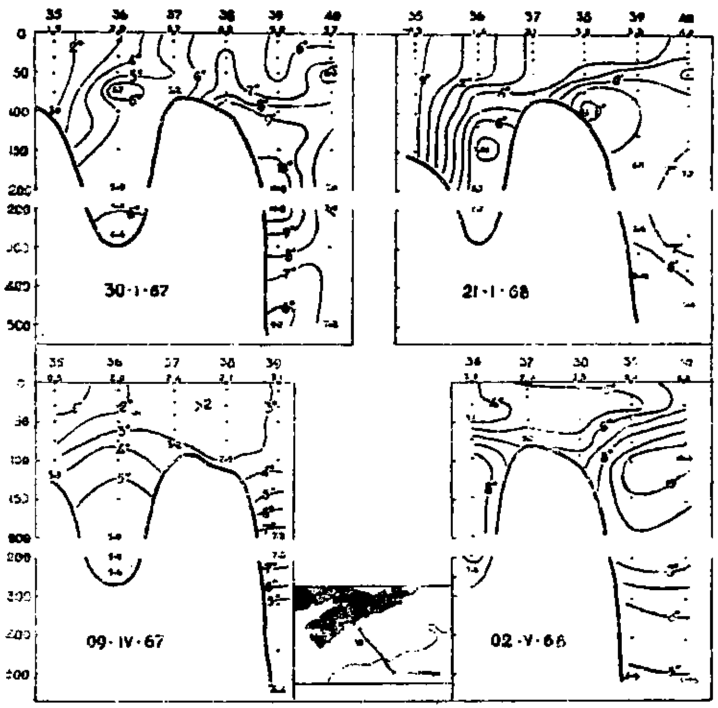

Fig. 6. Water temperatures in the Halifax section in winter and spring of 1967.

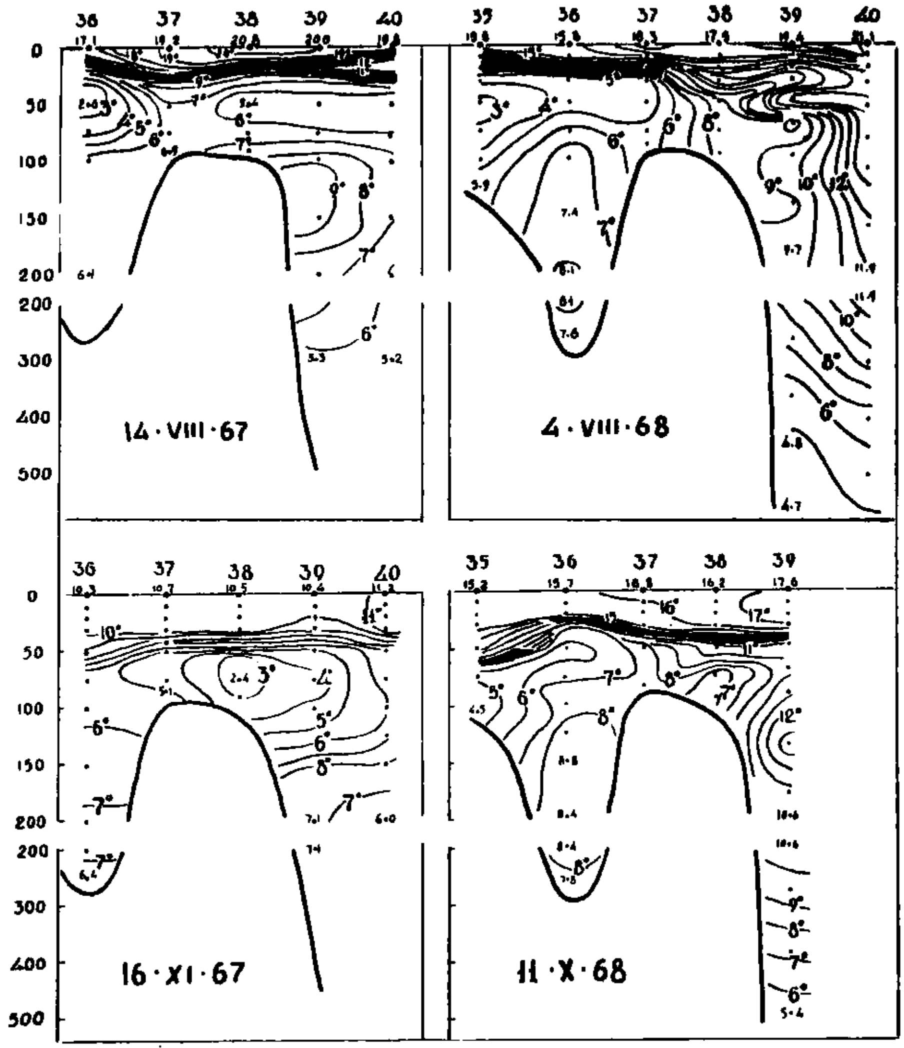

Fig. 7. Water temperatures in the Halifax section in summer and autumn of 1967 and 1968.

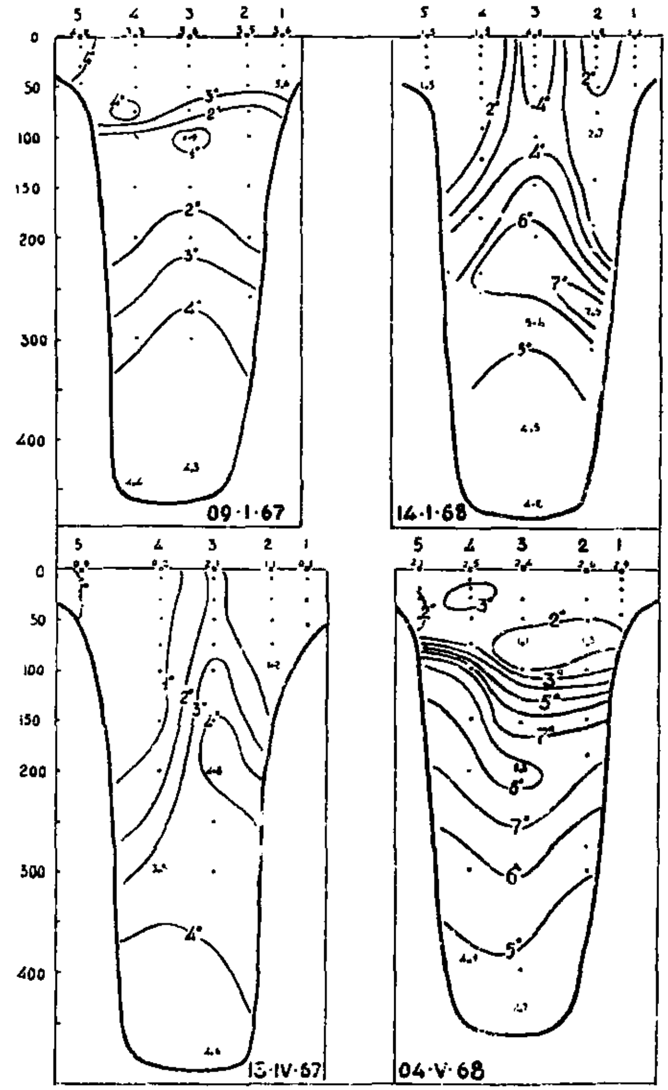

Fig. 8. Water temperatures in the Cabot Strait section in winter and spring of 1967 and 1968.

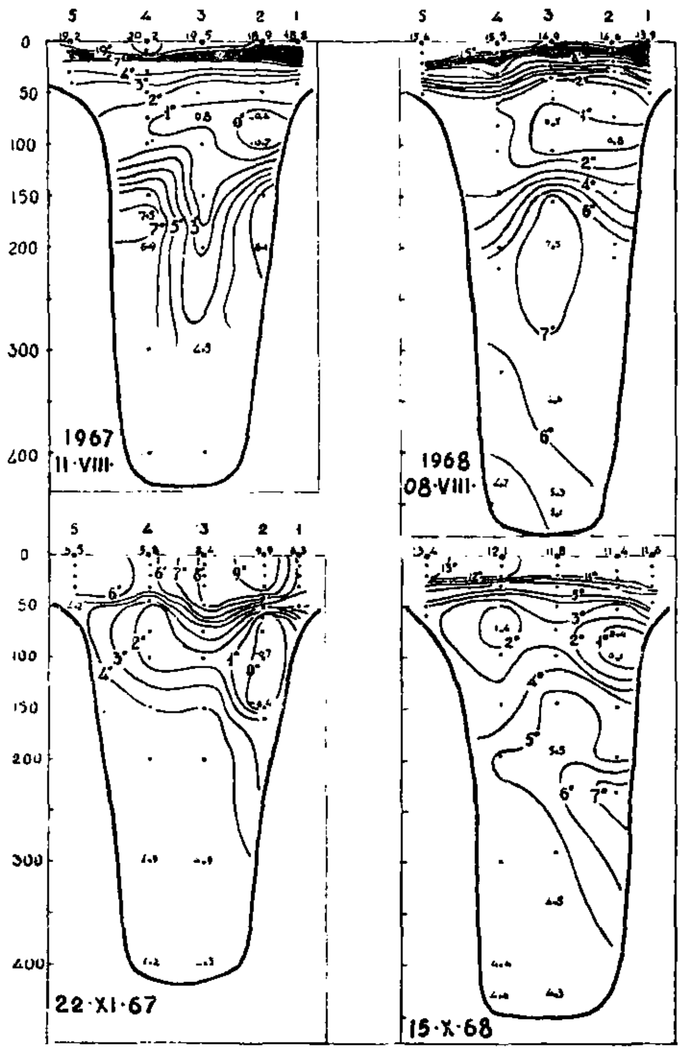

Fig. 9. Water temperature distribution in the Cabot Strait section in summer and autumn of 1967 and 1968.

8. Danish hydrographic investigations in West Greenland waters, 1968[1]

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and Marine Researches

The new research vessel *Adolf Jensen* worked a number of sections from April to November 1968 in the West Greenland bank area. The locations of the sections are shown in Fig. 1, and the temperature sections in Figs. 2-9.

The Fylla Bank section (section II) was worked most frequently, seven times in all between April and November.

In each month from April to August, temperatures in the upper 500 m were abnormally low off the western slopes of the banks. Over the shallow part of Fylla Bank the temperature was extremely low in the spring months but in June the summer heating had caused a rise in temperature to near the normal.

Table 1 shows the mean temperatures for the month of July calculated from observations in 15 years between 1950 and 1966 for the station just off the western slope of Fylla Bank (63°53'N:53°22'W) (F. Hermann 1967). The table also shows the temperature anomalies for July 1968 from these mean values.

Table 1.

Depth interval (m)	0-50	50-100	100-200	200-300	300-400	400-500	0-500
Mean temperature	2.07	1.33	1.85	2.88	3.79	4.22	2.89
Δ t, July 1968	-1.6	-1.8	-1.6	-1.3	-1.2	-1.2	-1.4

The July 1968 temperatures are extremely low for all water layers down to 500 m. Since 1950 in the years where temperature observations are available for July, only 1952 shows lower temperatures.

The July 1968 salinities for the same station were compared with the salinities observed in July in earlier years. Table 2 gives the mean value for the 1950-1966 period and the salinity anomalies for the individual years. High negative salinity anomalies dominated in all layers down to 500 m in July 1968. This with the prevailing low temperatures indicates a very strong inflow of polar water from the East Greenland Polar Current to the West Greenland area.

[1] submitted to the 1969 Annual Meeting of ICNAF as ICNAF Res. Doc. 69/59

In October and November the hydrographic situation changed completely. Off Fylla Bank all water layers below 75 m are mainly influenced by the warm Irminger Current, which in its core reached a temperature of 6° in November. The abnormally strong inflow of polar water apparently has stopped. As far north as the slope of Store Hellefiske Bank the temperature exceeded 5° in the core of the Irminger Current.

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Table 2. Salinity anomalies west of Fylla Bank (station r-3) in July.

Depth m	S‰ mean	1950	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1963	1964	1965	1966	1968
0	32.96	+0.31	+0.52	-0.01	+0.14	-1.40	+0.26	-0.19	-0.06	-0.22	-0.74	+0.26	+1.03	-0.11	+0.19	+0.02	-0.90
10	33.10	+0.20	+0.38	-0.03	+0.11	-1.10	+0.26	+0.05	-0.26	-0.39	-0.26	+0.48	+0.88	-0.26	+0.11	-0.13	-0.92
20	33.24	+0.11	+0.30	-0.12	+0.04	-0.65	+0.32	+0.32	-0.25	-0.40	-0.27	+0.39	+0.68	-0.36	+0.02	-0.15	-0.70
30	33.40	+0.09	+0.14	+0.01	-0.01	-0.20	+0.17	+0.23	-0.36	-0.44	-0.20	+0.34	+0.52	-0.26	+0.02	-0.12	-0.36
50	33.52	+0.26	+0.05	+0.16	+0.01	-0.19	+0.18	+0.25	-0.23	-0.52	-0.13	+0.32	+0.48	-0.28	-0.07	-0.17	-0.24
75	33.65	+0.35	+0.10	+0.22	-0.04	-0.17	+0.19	+0.19	-0.30	-0.43	-0.14	+0.23	+0.30	-0.23	-0.09	-0.15	-0.22
100	33.80	+0.34	+0.02	+0.26	+0.11	-0.11	+0.20	+0.16	-0.41	-0.49	-0.15	+0.15	+0.21	-0.25	+0.12	-0.18	-0.25
150	34.01	+0.33	-0.11	+0.30	+0.21	-0.29	+0.24	+0.34	-0.35	-0.42	-0.15	0.00	+0.05	-0.07	-0.09	-0.05	-0.30
200	34.20	+0.29	-0.19	+0.27	+0.20	-0.21	+0.30	+0.06	-0.27	-0.37	+0.09	-0.11	-0.04	-0.03	+0.07	-0.04	-0.19
300	34.58	+0.19	-0.41	+0.07	+0.20	-0.05	-0.12	-0.02	+0.05	-0.16	+0.03	-0.14	-0.20	+0.08	+0.14	+0.08	-0.20
400	34.75	+0.10	-0.51	-0.10		+0.02	-0.02	-0.04	+0.11	+0.14	+0.08	-0.03	-0.12	+0.07	+0.12	+0.11	-0.24
500	34.85	+0.04	-0.16	+0.04		-0.02	+0.01	-0.07	+0.07	+0.06	-0.01	-0.05	+0.08	+0.05		+0.07	-0.16

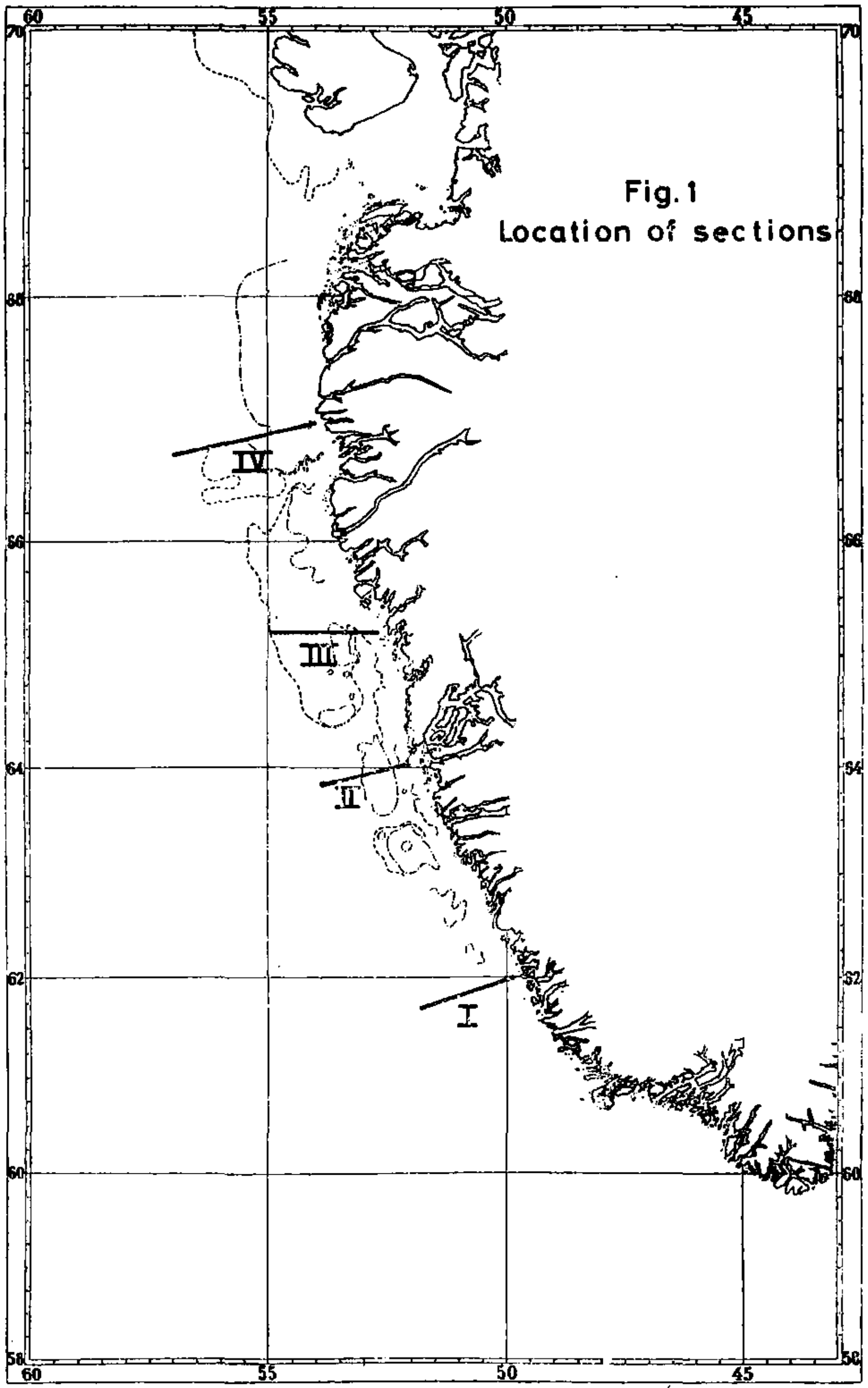
Fig. 1
Location of sections
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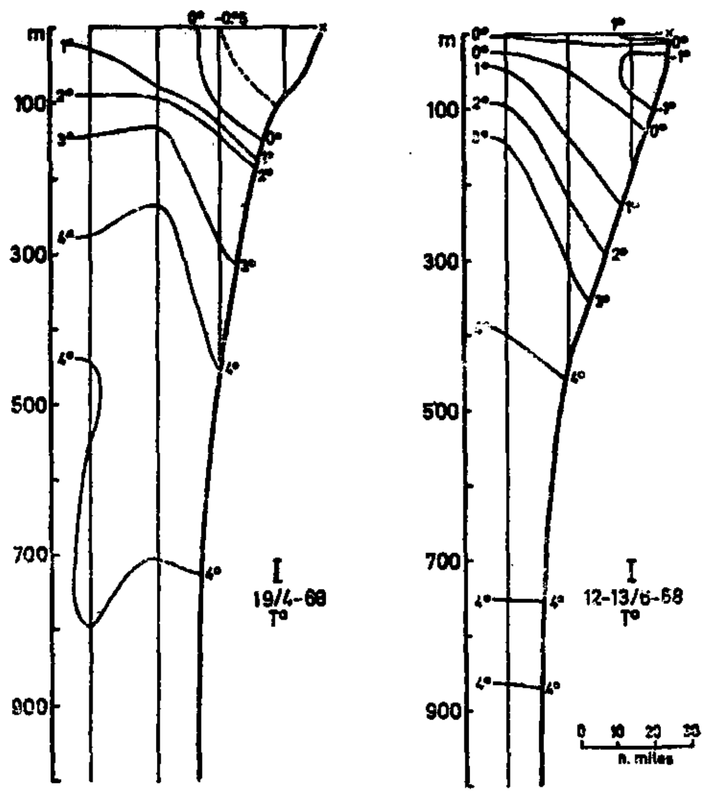

Fig. 2. Temperature sections off Frederikshåb in April and June.

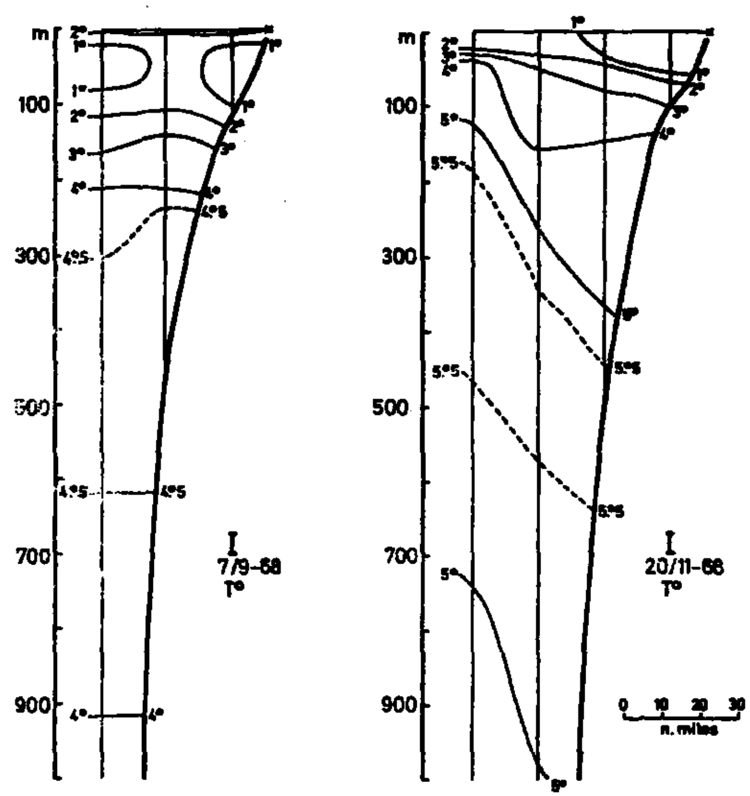

Fig. 3. Temperature sections off Frederikshåb in September and November.

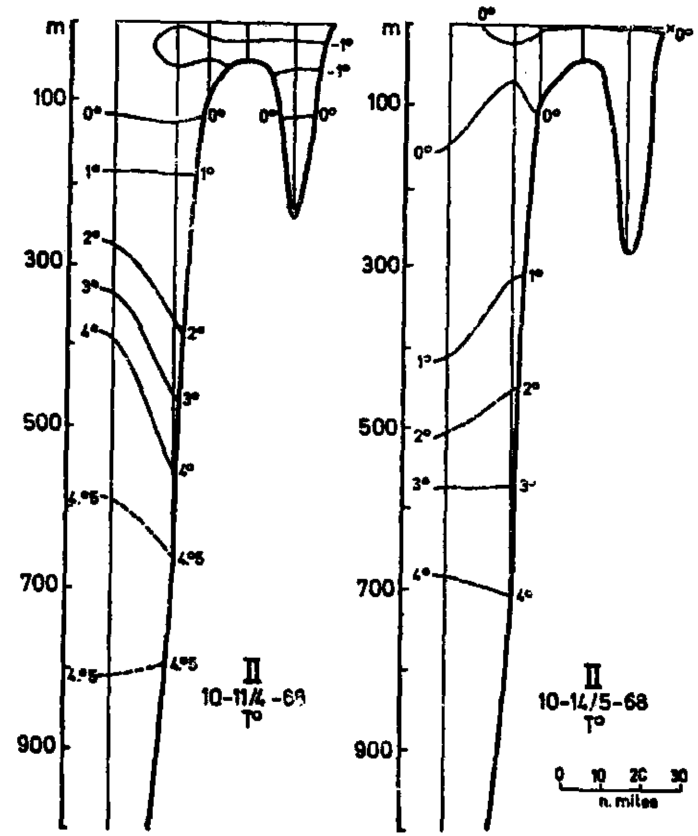

Fig. 4. Temperature sections over Fylla Bank, April and May

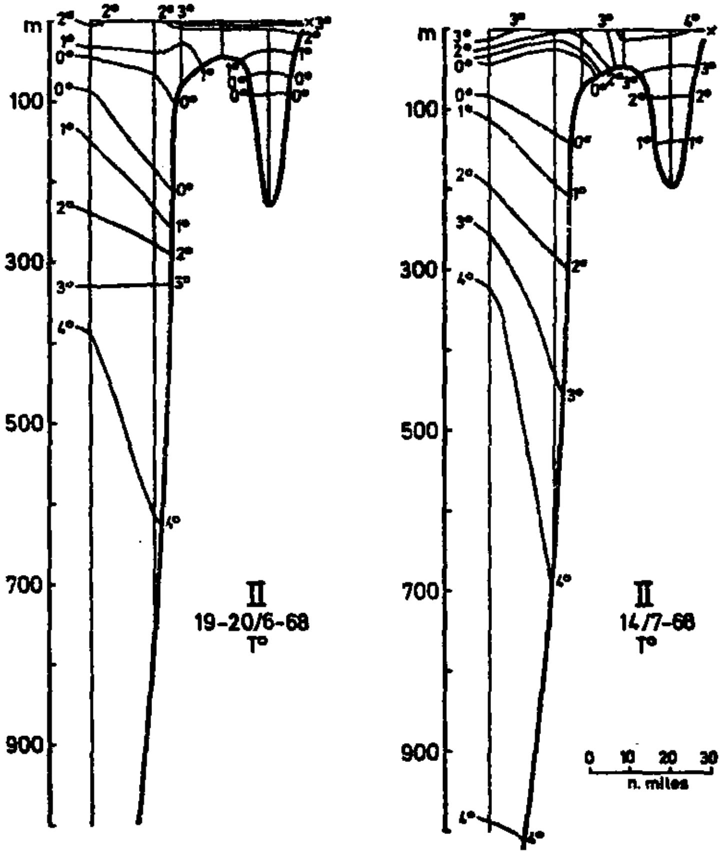

Fig. 5. Temperature sections over Fylla Bank, June and July.

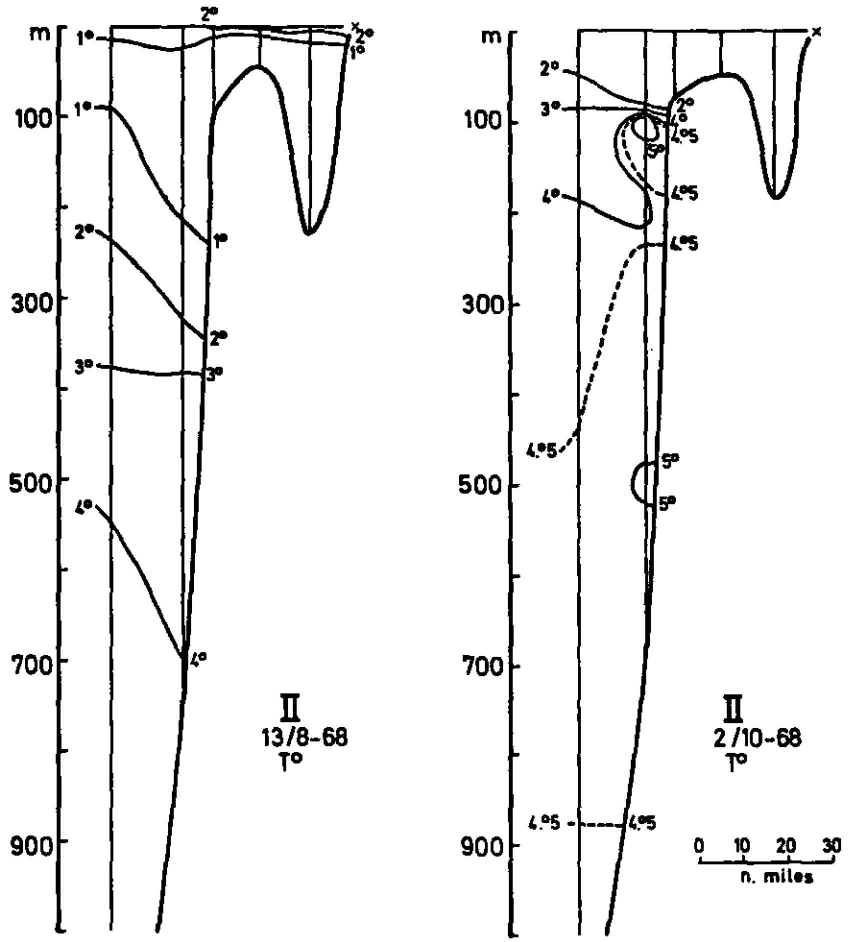

Fig. 6. Temperature sections over Fylla Bank, August and October.

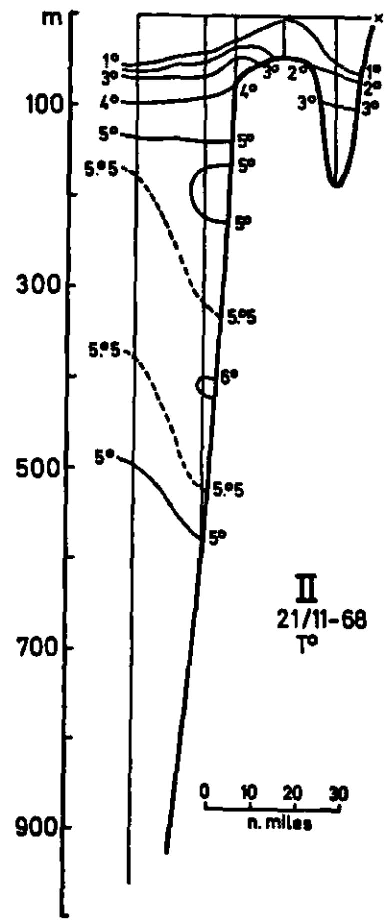

Fig. 7. Temperature sections over Fylla Bank, November.

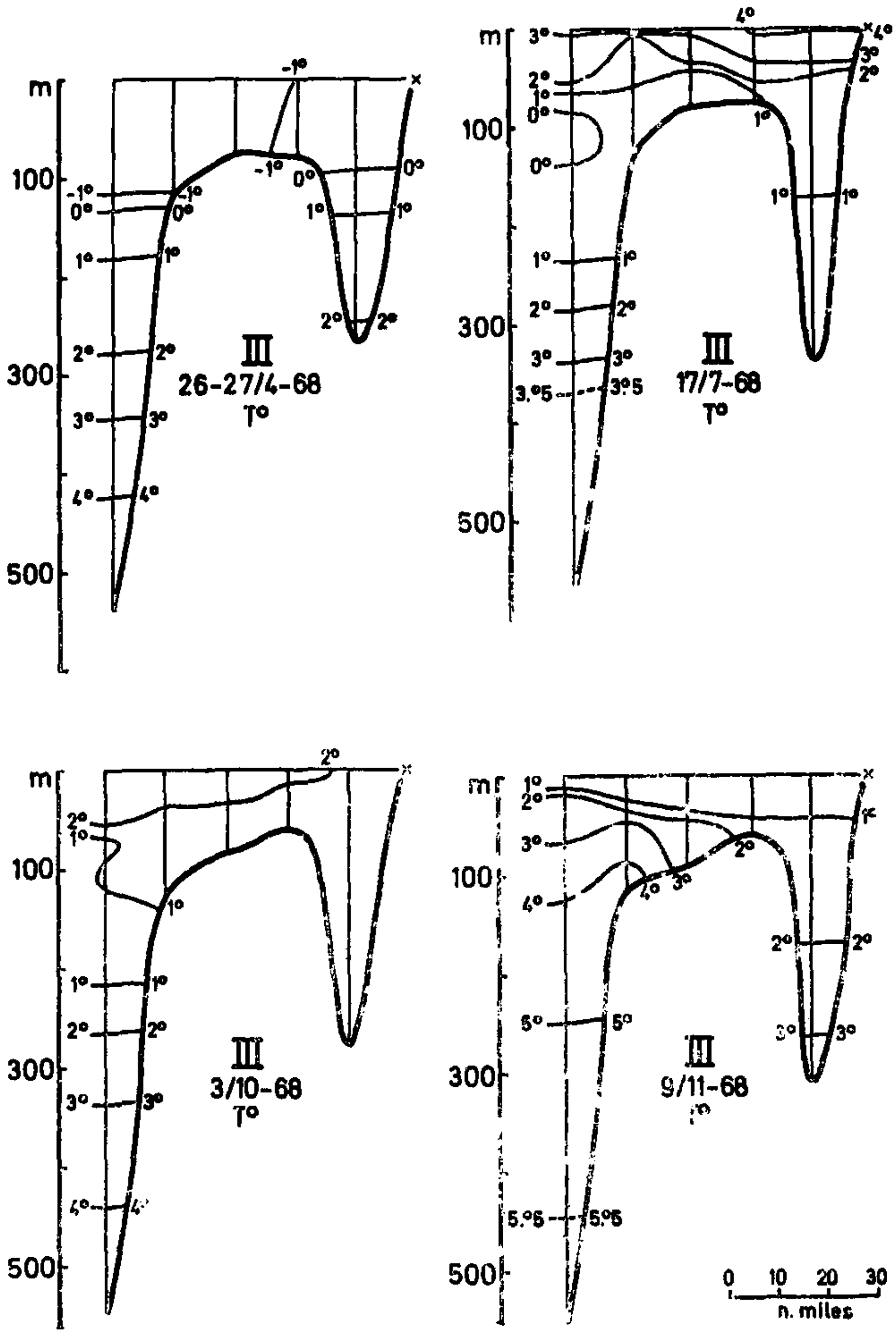

Fig. 8. Temperature sections over Lille Hellefiske Bank, April, July, October, November.

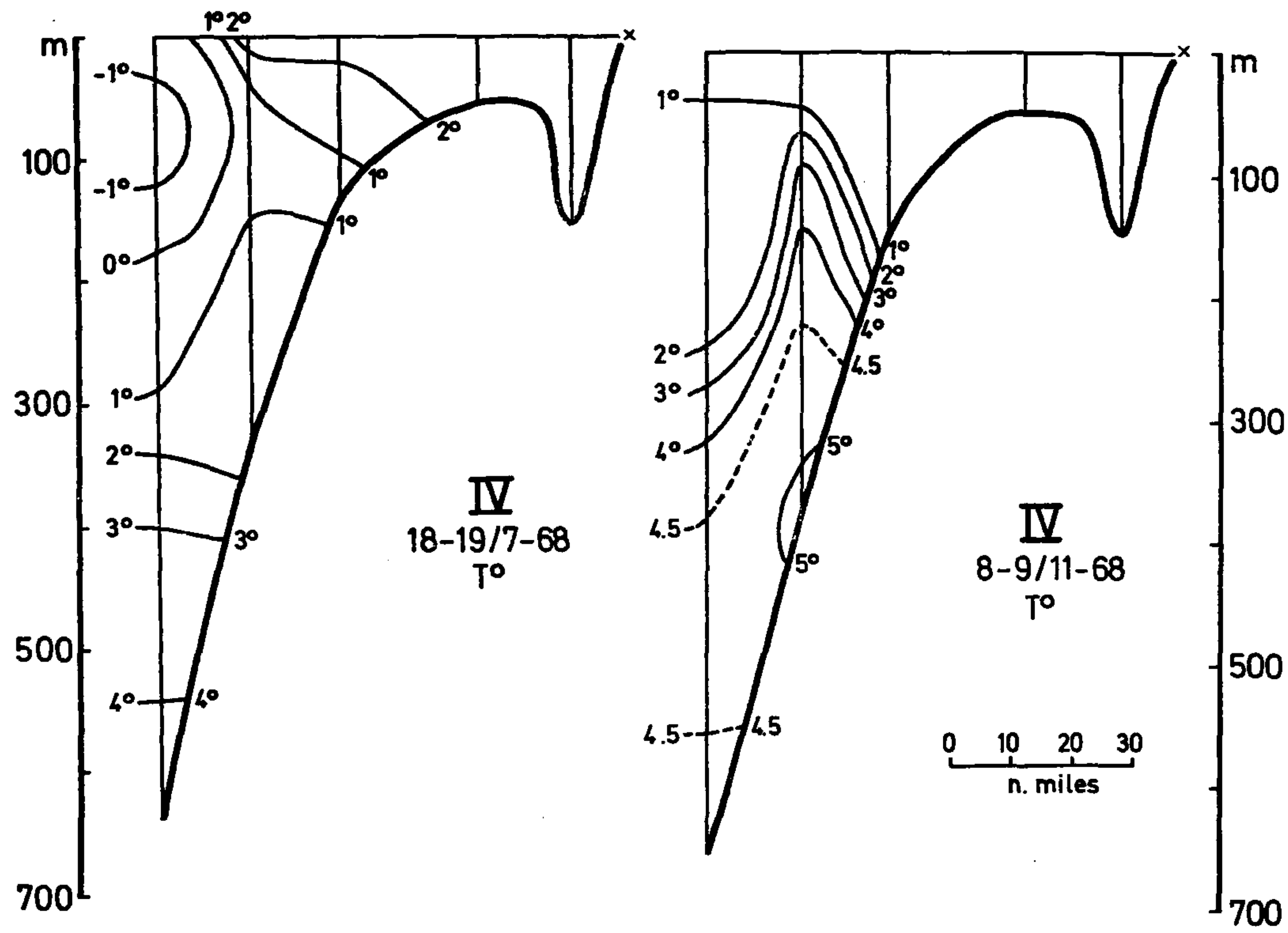

Fig. 9. Temperature sections over Store Hellefiske Bank, July and November

9. Hydrographic conditions in the Labrador and Newfoundland areas, 1968[1]

by V.V. Burmakin
PINRO

In 1968, oceanographic observations were made during two sea trips in ICNAF subareas 1, 2, and 3.

1. Young fish were counted and observations on t^o, S^o/oo, O_2, PO_4 - P, NO_3 - N were made in the North Newfoundland, Grand, Flemish Cap and Saint Pierre Bank areas at standard hydrographic sections 1-A' to 7-A' (Fig.1) during the tenth cruise of the R/V *Rossia*.

2. During the eighth cruise of the scouting BMRT *Neptun*, some temperature measurements were made on Section 8-A through Hamilton Inlet Bank during the periods from 31 October to 2 November and from 11 to 13 December, whereas the trawl stations were off Labrador - from 26 December to 8 January, 1968/69.

In April-May 1968, the water temperature from the surface to the bottom was 1^o to 2^o higher than in 1961, 1962, 1966, and 1967 on the Grand and Flemish Cap Banks, but was from 0.6^o to 1.0^o lower in the southern part of the North Newfoundland Bank.

In May-June, the inflow of warm Gulf Stream water became more intensive over the southern and southwestern areas of the continental slope of the Grand Bank. As a result the near-bottom temperature rose to between 8^o and 10^o at depths 100 m - 300 m compared with between 6^o to 7^o in the years with normal temperature conditions. The average temperature in the 0-200 m layer on the southwestern slope of Grand Bank in May 1968, was the same as in 1963 (1.94^o to 2.29^oC) and 0.5^o to 1.0^o higher than in 1961 (no observations were made in May of previous years on this slope).

Temperature data from Section 8-A through Hamilton Inlet Bank in August-December 1958, 1962, 1964, 1965-1968 were adjusted to those of the first of November to make them comparable. For this purpose, all temperature data in the various layers were plotted according to the dates when they were obtained (Fig.2).

From a series of continuous observations completed during some months in 1962 and 1964 and from 1966 to 1968, average daily changes in temperature were calculated for each layer. These changes for the surface layer from September to November were negative due to atmospheric cooling.

[1] submitted to the 1969 Annual Meeting of ICNAF as ICNAF Res.Doc.69/62.

In 50-200 m, 200-500 m and 0-200 m layers, the temperature increased from September to November due to an increase in the warm subsurface component of the Labrador Current during the autumn months (Burmakin, 1968).

All the observations given for the different months were then adjusted to 1 November by interpolation and extrapolation (Table 1).

Table 1. Average temperature (°C) of the cold component of the Labrador Current in Section 8-A (area AB of Fig.1), adjusted to the first of November for different years and layers.

Depths m	1958	1962	1964	1965	1966	1967	1968	Average	Anomaly 1968
0-50	1.28	1.58	0.98	1.30	2.41	2.00	2.29	1.69	+0.60
50-200	0.59	1.34	-0.18	1.06	1.44	0.89	-0.18	0.71	-0.89
0-200	0.79	1.49	0.17	1.13	1.72	1.19	0.50	1.00	-0.50
200-500	-	1.70	0.98	-	2.47	0.95	0.31	1.28	-0.97

As seen from Table 1, in November 1968 the temperature of the cold component of the Labrador Current in the layers below 50 m was from 0.50° to 0.97° below the long-term average, and in the surface layer (0-50 m) 0.60° above it. Thus, as a result of a higher intensity of the cold component of the Labrador Current, the water temperature in November 1968 was the lowest for the last four years in spite of the higher solar warming in summer, which was mentioned above.

As Fig.2 shows, from 1 November to 12 December, 1968, the lowering in temperature (from 2.29° to -0.10° in the 0-50 m layer and from 0.50° to 0.18° in the 0-200 m layer) was observed in the surface layers in area AB of Section 8-A (Fig.1) due to cooling. At the same time, the temperature in the layers below 50 m rose sharply from 0.31° to 1.24° in the 200-500 m layer and from -0.18° to 0.26° in the 50-200 m layer due to the inflow of the warm component onto the slope. But, according to observations at bottom stations in the near-bottom layers of the South Labrador and North Newfoundland Banks (Fig.3) late in December 1968 and in January 1969, waters with temperature below 2° were spread 10-15 miles farther eastward than in the same months 1963/64 and 1966/67.

Based on the temperature in the near-bottom layers, the 1968/69 winter is believed to have been similar to the 1964/65 winter. This can be confirmed from the observations in the 1968 pre-winter period (Table 1).

Preliminary data on water temperature in subsections B and C of Section 8-A (Fig.1) were obtained by BRT *Volgograd* on 28 February, 1969. These data also confirm the conclusions on the decrease in temperature of the cold component of the Labrador Current for this year. These February

1969 observations can be compared with those for 27 February, 1967. Table 2 shows these observations for different layers at Section 8-A, subsections B and C.

Table 2. Water temperature in various layers of subsections B and C of Section 8-A in February 1967 and 1969

Date	Subsection B				Subsection C			
	0-50 m	0-200 m	50-200 m	200-500 m	0-50 m	0-200 m	50-200 m	200-500 m
27 February, 1967	-1.06	0.42	1.01	3.09	2.53	3.46	3.77	3.87
28 February, 1969	-1.10	0.20	0.70	2.70	-0.80	1.30	2.00	4.00
Difference in temperature, 1969-1967	-0.04	-0.22	-0.31	-0.39	-3.33	-2.16	-1.77	+0.13

Table 2 shows that, to the end of February 1969 in comparison with 1967, a strong cooling of surface waters (0-50 m layer) in subsection C of Section 8-A was observed at the same time as the decrease in temperature in the core of the cold Labrador Current (50-200 m layer).

References

Burmakin, V. V. 1968. Hydrological conditions in the Labrador and Newfoundland Areas in 1967, *Annu. Meet. int. Comm. Northw. Atlant. Fish.*, Res. Doc. 68/37 Ser. No. 2015.

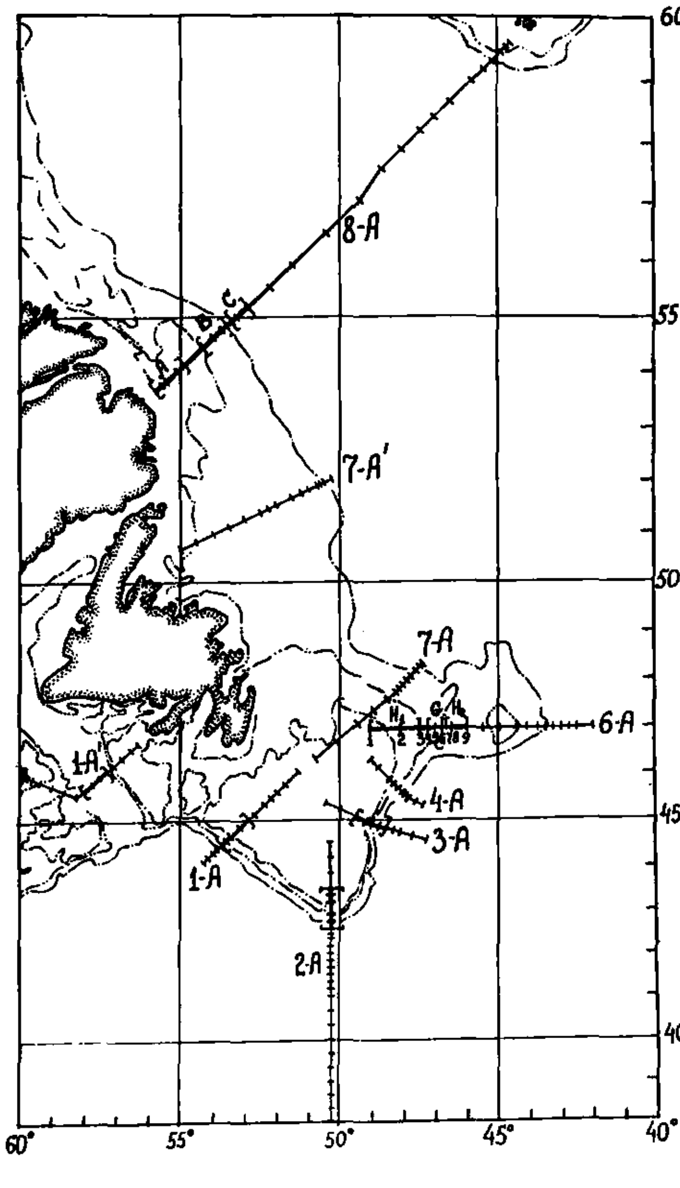

Fig. 1. Location of standard hydrographic sections in the Labrador and Newfoundland areas.

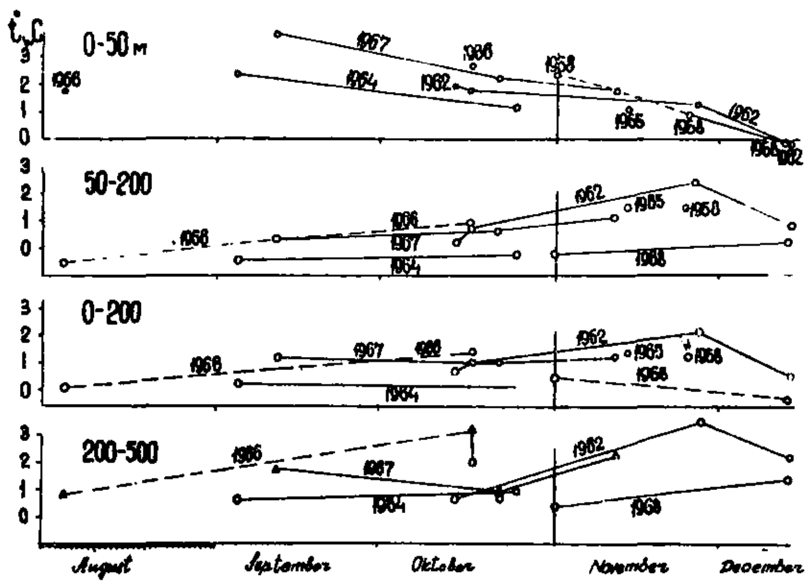

Fig. 2. Changes in water temperature from August to December 1958, 1962, 1964 and 1965-1968 in the cold component of Labrador Current (area A B) at Section 8A, across Hamilton Inlet Bank, layers 0-50, 50-200, 0-200 and 200-500 m.

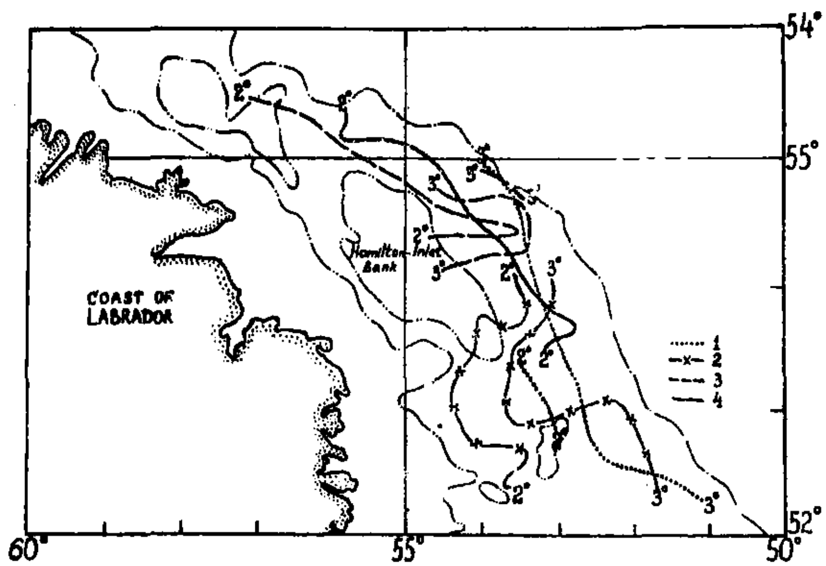

Fig. 3. Position of the 2° and 3° isotherms, December-January over the South Labrador and North Newfoundland Banks.
1. 1963/64; 2. 1964/65; 3. 1966/67 and 4. 1968/69

SECTION D
SALMON

10. Utilization of three stocks of Atlantic salmon tagged and liberated as smolts in the Northwest Miramichi River[1] from 1964 to 1967

by P.F. Elson
Fisheries Research Board of Canada
Biological Station, St. Andrews, N.B.

Returns from 149,398 tagged Atlantic salmon smolts liberated in the years 1963-1966 were summarized in ICES/ICNAF Salmon Doc. 68/14. Of the 1,929 returns (1.3% overall recovery rate), 12% were recorded from the West Greenland area and 88% from Canadian waters. As noted in ICES/ICNAF Salmon Doc. 69/10 ("Canadian tagging data for Atlantic salmon to February 28, 1969"), these tagged smolt releases involved fish of different stock origins and rearing histories, liberated in different rivers. Survival rates varied considerably between groups of fish. Meaningful year-to-year comparisons of dispersal patterns and return rates should take account of the different groups of fish and places of liberation.

Year-to-year comparisons do have validity for three stocks of fish liberated in the Northwest Miramichi River, New Brunswick, in the years 1964 to 1966. Similar kinds of tagged smolts were also liberated in this stream in 1967, but for these the important returns as 2-sea-winter fish will not be available until the end of the 1969 season: data on returns of these fish before completion of their second sea winter are, however, included in the tables with some interpretation of their significance given as footnotes.

The three stocks include wild, native Northwest Miramichi smolts; hatchery-reared smolts from a mixture of grilse and salmon parents which ascended five miles into Northwest Miramichi fresh water after September, and regarded as late-run; and hatchery-reared smolts from a mixture of grilse and salmon parents which ascended five miles into Northwest Miramichi fresh water before August 1, regarded as early-run.

The hatchery-reared smolts were reared in hatcheries offering warmer water, hence faster growth, than the Miramichi area. They were mostly tagged and liberated as 2-year-old smolts. Tagging was done at the rearing hatchery in March. Liberation was in the northwest Miramichi in late May, the height of the local season for smolt descent. Fish were released five miles or farther above tidehead, in fresh water. Returns showed nearly all freshwater recaptures in the river of liberation. That dispersal at sea was similar to that for wild smolts from the same stream is shown in Fig. 1 and 2 (see also Saunders, R.L. 1969. *J. Fish. Res. Bd. Canada*, 26: 269-278).

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[1] submitted to the 1969 Annual Meeting of ICNAF as ICNAF Res.Doc.69/72, (also ICES/ICNAF Salmon Doc.69/14).

Wild, native smolts

Wild smolts are produced mostly in the upper 50 miles of the 70-mile-long river. The lower 20 miles is periodically subjected to copper-zinc pollution at levels lethal to young salmon. The uppermost 30 to 40 miles is populated mostly by grilse and salmon entering before August 1 (Saunders, R.L. 1967. *J. Fish. Res. Bd. Canada,* 24: 21-32), but many late fish spawn in the lower reaches including about 20 miles immediately above the source of pollution.

Most of the native smolts are 3 years old, thus most 1964 smolts were derived from the 1960 autumn spawning. In that year the ratio of large salmon-grilse entering the river was 1:7; other such ratios were 1961 - 1:1, 1962 - 1:10, 1963 - 1:20, the latter resulting in most of the 1967 wild smolts.

The above facts would seem of little import except that evidence is accumulating which appears to point to genetic constitution having some influence on behaviour patterns as regards both season of return and age at maturity.

Table 1 gives summarized data on returns from wild smolts.

Comparatively low returns as grilse from the 1965 smolts, together with high returns from Greenland, where most tagged Canadian fish are entering their second sea winter, is in keeping with a hypothesis that a high salmon component among the spawners (in 1961) should contribute fish older than grilse. However, the grilse returns for the 1964 and 1966 smolts, though higher than for 1965 smolts, suggest that any such relationship is far from precise.

Late-run, hatchery-reared smolts

Table 2 gives summarized data on returns from hatchery-reared smolts of late-run parentage.

As with the wild smolts, the 1964 run yielded a relatively high proportion of grilse, although these smolts (from 1961 spawners) were a year younger than most of the wild smolts of 1964; the 28 returns are, however, low and do not merit much emphasis. The late-run smolts of 1966 gave a relatively small proportion of grilse although the wild smolts of 1966 gave many grilse. Both wild and hatchery-reared smolts of 1966 arose from spawning populations with high grilse:salmon ratios.

Early-run, hatchery-reared smolts

Table 3 gives summarized data on returns from hatchery-reared smolts of early-run parentage.

The first substantial planting of such fish was made in 1965. The first two plantings yielded a higher proportion of grilse than the wild and late-run smolts tagged in these two years.

Utilization of large salmon

In Canada, other than in Newfoundland, commercial fisheries for Atlantic salmon depend largely, though not entirely, on salmon older than grilse. Salmon making their first return after 2 winters at sea are the mainstay. In Newfoundland grilse contribute variably but always substantially, forming perhaps half of the fish caught. The larger fish, too, are much more prized by anglers than are the grilse.

Most of the salmon of known Canadian origin taken in the new fisheries of the West Greenland-Davis Strait area are in their second sea winter. If a substantial portion of these fish would otherwise have returned to Canadian waters, then the exploitation rates to which they are subjected in distant waters will have bearing on the success of Canadian fishermen. This is particularly liable to be the case if exploitation rates in home waters are high (Allen, K.R., and R.L. Saunders. 1967. ICNAF Redbook, Pt,III, p.159-180).

The overall data available for each year's recaptures of tagged smolts show sufficient variability to give cause for wondering whether, in some recent years more than others, more Canadian fish appeared in these northern waters. Some variability may be an artifact based on the use of different kinds of fish for studying comparative values for utilization.

Examination of Tables 1 to 3 shows that much of the variability has no obvious relationship to year of smolt descent, but is rather associated with different survival and migratory patterns of different groups of fish.

The data do pertain to eight groups liberated over three different years. They appear to have merit for indicating mean values, with standard deviations, for capture of Canadian fish in the Greenland area versus returns, as 2-sea-winter and older fish, to home waters.

Combining the three right-hand columns of the three tables, about 20 ± 8% were exploited in Greenland, about 77 ± 9% were removed by Canadian fisheries and a little over 3% (3.5 ± 3) were recorded as spawning escapement in the home river.

Considering only those large salmon recorded from Canadian waters, 76 ± 16% were used in commercial fisheries; 20 ± 13% in sport fisheries and 4 ± 4% were recorded as spawning escapement. By way of contrast, of the fish recorded as grilse only 75% were used in fisheries and 25% were recorded as spawning escapement.

The recently observed exploitation rate for large salmon appears to be much higher than the approximately 70% suggested in one study, (Elson, Paul F. 1962. Atlantic Salmon Journal, No.2 p. 16-18, June, 1962) as admissable for year-classes of better than average strength. If there is no genetic influence on age and size at maturation, then it may only be necessary to maintain a sufficient escapement of grilse. If there is such genetic influence, then present stocks of large salmon in the northwest Miramichi and perhaps other Canadian rivers may now be critically low. Many Canadian freshwater Atlantic salmon environments, including the large Miramichi and Saint John systems, are now subject to deterioration resulting from industrialization. Year-classes of better than average strength should probably be expected less frequently than even 10 years ago.

Table 1. Returns from tagged, wild Northwest Miramichi smolts. (Escapement = fish recorded in counting weirs and brood stock collection but not subsequently in fisheries).

Year tagged	Number tagged	Total returns		Grilse reported in Canada as % of total adult returns	2-sea-winter & older fish as % of total large salmon returns		
		number	% of tagged smolts		Greenland fisheries	Canada fisheries	Canada escapement
1964	12,996	267	2.1	65	10	88	2
1965	15,361	429	2.8	38	27	70	3
1966	8,450	225	2.7	48	21	74	5
1967	11,763	80*	0.7*	-	(13 fish)**	-	-

* Grilse in Canada and 2-sea-winter fish in Greenland (to Feb.28 1969) compare with 1.4, 1.5 and 1.6% returns from 1964, 1965 and 1966 liberations.

** Ratio of grilse in Canada: 2-sea-winter fish in Greenland for smolts of 1964 - 25:1, 1965 - 2:1, 1966 - 5:1, 1967 - 5:1.

Table 2. Returns from tagged, hatchery-reared smolts from late-run mixed grilse and salmon parentage, liberated in the Northwest Miramichi River. (Escapement = fish recorded in counting weirs and brood stock collections but not subsequently in fisheries).

Year tagged	Number tagged	Total returns: number	Total returns: % of tagged smolts	Grilse reported in Canada as % of total adult returns	2-sea-winter and older fish as % of total large salmon returns: Greenland fisheries	Canada: fisheries	Canada: escapement
1964	11,533	28	0.2	64	30	60	10
1965	4,797	120	2.5	45	15	80	5
1966	18,314	248	1.4	18	22	77	1
1967	14,440	66*	0.5*	-	(7 fish)**	-	-

* Grilse in Canada and 2-sea-winter fish in Greenland (to Feb.28 1969) compare with 0.2, 1.3 and 0.5% returns from 1964, 1965 and 1966 liberations

** Ratio of grilse in Canada: 2-sea-winter fish in Greenland for smolts of 1964 - 6:1, 1965 - 5:1, 1966 - 1:1, 1967 - 8:1.

Table 3. Returns from tagged, hatchery-reared smolts from early-run mixed grilse and salmon parentage, liberated in the Northwest Miramichi River. (Escapement = fish recorded in counting weirs and brood stock collections but not subsequently in fisheries).

Year tagged	Number tagged	Total returns: number	Total returns: % of tagged smolts	Grilse reported in Canada as % of total adult returns	2-sea-winter and older fish as % of total large salmon returns: Greenland fisheries	Canada: fisheries	Canada: escapement
1965	10,026	330	3.3	58	25	75	0
1966	13,802	236	1.7	61	10	88	2
1967	15,517	150*	1.0*	-	(2 fish)**	-	-

* Grilse in Canada and 2-sea-winter fish in Greenland (to Feb. 28 1969) compare with 2.2 and 1.1% returns from 1965 and 1966 liberations.

** Ratio of grilse in Canada: 2-sea-winter fish in Greenland for smolts of 1965 - 6:1, 1966 - 16:1, 1967 - 74:1.

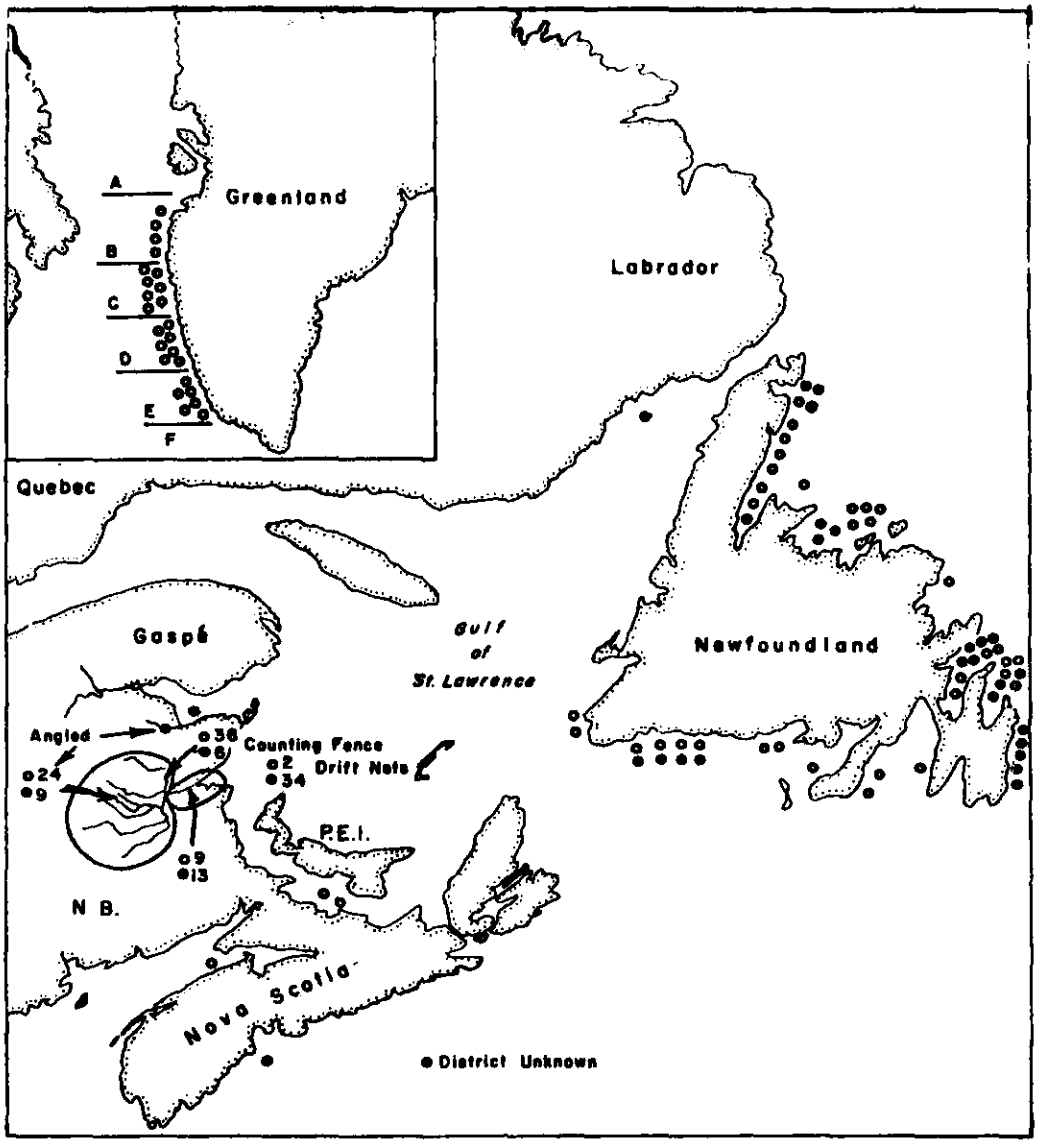

Fig. 1. Recaptures from 8,450 Atlantic salmon tagged as wild, native smolts at a counting fence while descending the Northwest Miramichi River, New Brunswick, in May and June, 1966. Open circles - taken as 1-sea-winter fish (130); solid circles - taken as 2-sea-winter or older fish (93).

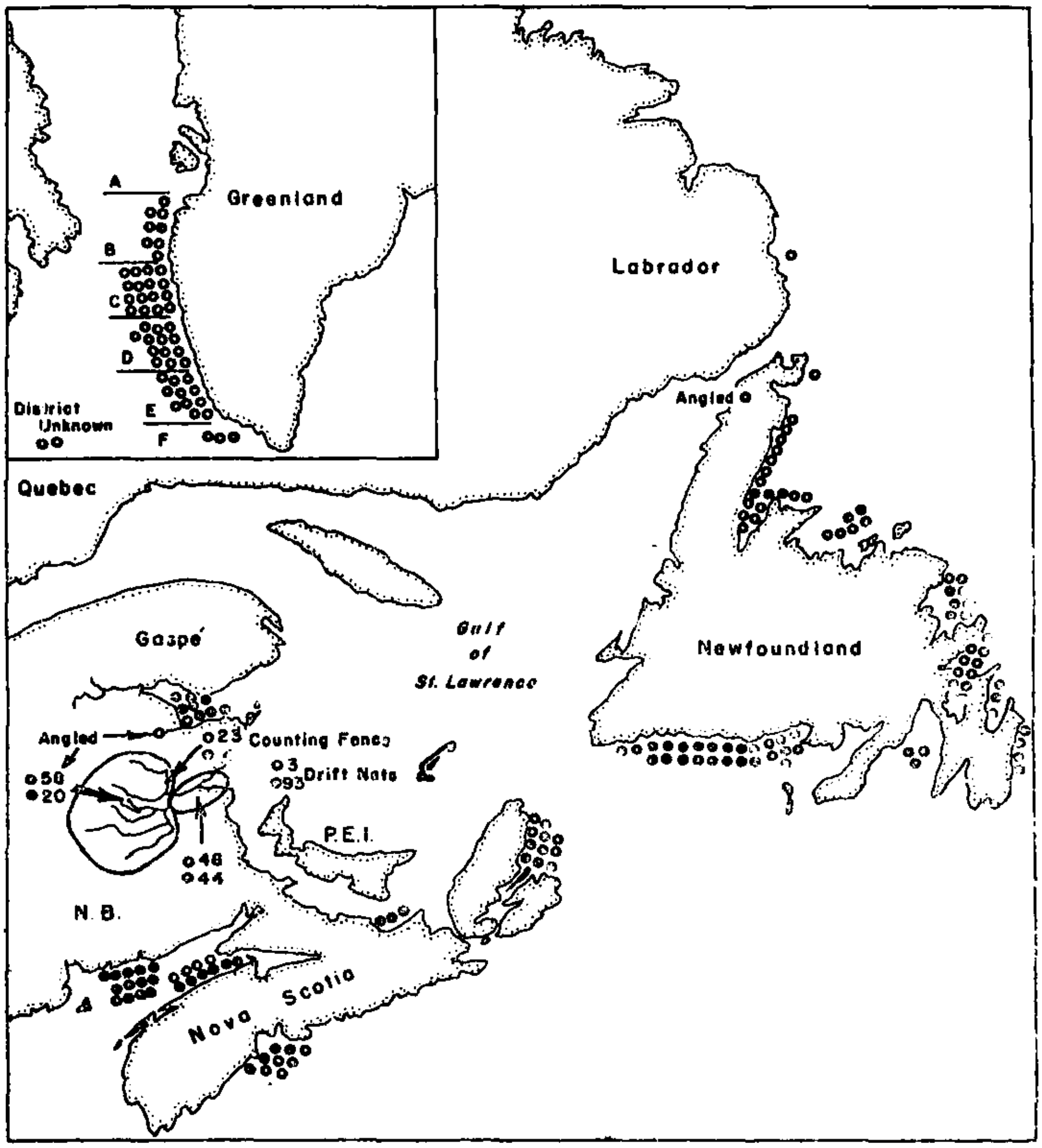

Fig. 2. Recaptures from 18,314 Atlantic salmon hatchery-reared smolts of late-run mixed grilse and salmon parentage and 13,802 hatchery-reared smolts of early-run mixed grilse and salmon parentage; liberated in the Northwest Miramichi River, New Brunswick, in late May 1966. Open circles - taken as 1-sea-winter fish (243); solid circles - taken as 2-sea-winter or older fish (241).

SECTION E
SAMPLING

11. The effects of icing and freezing on the length and weight of groundfish species[1]

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Acadia University, Wolfville, N.S.

Introduction

Death and preservation change both the length and weight of a fish from its live "normal" condition. A knowledge of such changes is frequently of importance, *e.g.* in deducing the fresh length of tagged fish returned by commercial vessels, in the enforcement of minimum length regulations for fishery conservation, and in deducing the fresh length and weight of specimens preserved for laboratory examination.

The present paper presents data on the effects of icing and freezing on the lengths and weights of cod (*Gadus morhua* L.), haddock (*Melanogrammus aeglefinus* (L.)), American plaice (*Hippoglossoides platessoides* (Fabricius)), winter flounder (*Pseudopleuronectes americanus* (Walbaum)), and Atlantic argentine (*Argentina silus* (Ascanius)). No data have previously been presented for winter flounder or argentine and very little for haddock.

A considerable body of published data has accumulated on the effects of death and of preservation in formalin and alcohol, and by icing and freezing. However, this literature is widely scattered and, as a review seems called for, this is presented here.

Material and Methods

Cod used in icing experiments were caught by a commercial inshore longline vessel out of Lockeport, N.S., and landed gutted. These were measured and weighed ashore within 5 hours of removal from the sea and before rigor mortis set in. A few were just beginning to stiffen. After measurement they were placed in boxes with ice.

Cod, haddock, plaice and winter flounder used in freezing experiments were captured by otter trawl in Passamaquoddy Bay, N.B. These were measured on deck within 45 minutes of capture - usually within a much shorter time - tagged, and placed in tanks of running sea water. The fish remained in the tanks 1-4 hours before they could be taken ashore and weighed. Although survival in the tanks was good, particularly among plaice and winter flounder, most fish were dead on weighing. Immediately after weighing the fish were placed individually in air-tight plastic bags and stored in a freezer at -16°C.

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Argentines captured on the Nova Scotian and St. Pierre Banks were measured immediately after capture, sometimes tagged, placed in plastic bags in numbers between 10 and 25 per bag, and put in a freezer aboard ship. One sample after measurement was stored in ice for 24 hours, remeasured and weighed, then frozen in a plate freezer in plastic bags containing 10 fish each.

All frozen fish were thawed in fresh water and remeasured and reweighed immediately thawing was complete.

Results

Effects of icing

To determine the effects of icing on length and weight of cod, 50 fish were iced and stored for 17 hours and a further 55 were stored in ice for 41 hours before reweighing and remeasuring. The latter group were re-iced for a further 24 hours, then weighed and measured again.

The average length decreased by 0.4% after 17 hours in ice but increased again slightly after 41 hours to -0.2%, and after 65 hours there was an increase over the original length of 0.8% (Table 1). Weight after 17 and 41 hours on ice was 1.0% higher than when fresh but, after 65 hours, had dropped to -0.6% of the original weight. Only in the weight change after 17 hours was the magnitude of the change related to initial length, smaller fish gaining slightly more weight than larger fish ($P = 0.05$).

Table 1. Effects of icing on the length and weight of cod. (Combined results of two experiments; measurements after 41 and 65 hours based on the same fish.)

Fork length (cm)	17 hours			41 hours			65 hours		
	No.	% length change	% weight change	No.	% length change	% weight change	No.	% length change	% weight change
45-49	6	-0.7	+1.6	11	0.0	+1.5	11	+0.8	-0.6
50-54	9	-0.4	+2.2	10	-0.4	+1.3	10	+1.0	-0.8
55-59	11	0.0	+1.1	11	+0.2	+0.3	11	+1.4	-0.9
60-64	6	-0.5	+0.5	13	-0.5	+1.2	13	+0.4	-0.7
65-69	9	-0.3	+0.4	4	-0.7	+0.3	4	+1.1	-0.2
70-74	6	-0.7	+0.2	5	-0.3	+0.8	5	0.0	+0.4
75-79	3	0.0	+0.3	1	+1.3	+0.9	1	+1.3	0.0

One hundred and thirty six argentines stored in ice for 24 hours lost 0.5% of their fresh length (Table 2). The slope of the regression equation of percentage change on fish length did not differ significantly from zero ($P = 0.05$), indicating that the percentage loss did not vary with fish length.

Table 2. Effects of icing for 24 hours and subsequent freezing for 2 months on the length of argentines. (* - significant at 5% level.)

Standard length cm	No.	% length change after icing	% length change after freezing
22	1	-1.3	-3.5
23	2	0.0	-2.4
24	11	-0.3	-2.4
25	9	-0.7	-2.3
26	10	-1.0	-2.7
27	11	-0.6	-2.7
28	8	-0.9	-2.6
29	10	-0.4	-2.3
30	11	-0.6	-2.3
31	12	-0.4	-2.2
32	11	-0.8	-2.0
33	11	-0.4	-1.9
34	9	-0.8	-2.3
35	8	-0.4	-2.2
36	11	-0.5	-2.2
37	1	-0.8	-2.1
Average		-0.5	-2.3
Regression parameters			
Elevation		-1.1467	-3.4682
Slope		0.0200	0.0385*
Correlation coefficient		0.2858	0.6218

Table 3. Effect of freezing on the length of argentines. (T.L. = total length; F.L. = fork length; S.L. = standard length.)

Cruise	Sample No.	Length measured	% change
C.126	1	F.L.	-5.0
"	2	"	-5.1
"	3	"	-5.5
"	4	"	-5.9
C.127	1	F.L.	-6.3
C.131	1	F.L.	-3.9
C.142	1	T.L.	-2.3
"	"	F.L.	-2.5
"	"	S.L.	-3.3

Table 4. The relationship between percentage change and initial length in argentines (* - significant at 5% level).

Fork length cm	C.126 No.	C.126 % change	C.131 No.	C.131 % change
21	13	-5.1	-	-
22	20	-4.9	-	-
23	17	-5.1	-	-
24	26	-4.9	-	-
25	43	-5.5	-	-
26	40	-6.0	-	-
27	37	-5.1	-	-
28	23	-5.6	-	-
29	38	-5.1	-	-
30	28	-5.6	9	-3.3
31	18	-5.4	11	-3.5
32	17	-5.5	26	-3.7
33	28	-5.4	28	-3.9
34	20	-5.2	28	-4.1
35	11	-5.9	18	-3.7
36	9	-5.2	9	-4.4
Regression parameters				
Elevation	-0.7195		1.0219	
Slope	-0.0209		-0.1464*	
Correlation coefficient	-0.3314		-0.8558	

Table 5. Effects of freezing for 2 months on the weight of argentines which had been on ice 24 hours before initial weighing (** - significant at 1% level).

Original weight g	No.	% weight change
100-149	6	+1.6
150-199	31	+1.1
200-249	13	+1.1
250-299	14	+0.6
300-349	13	+1.0
350-399	16	+0.4
400-449	8	+0.5
450-499	10	+0.3
500-549	6	+0.4
550-599	4	-0.4
600-649	-	-
650-699	1	+0.2
Average		+0.8

Regression parameters	
Elevation	1.6864
Slope	-0.0028**
Correlation coefficient	-0.8675

Effects of freezing

Seven separate argentine samples were measured fresh, frozen aboard ship, and thawed after a time period of at least 1 month. The loss in length varied from 2.3-6.3% among samples (Table 3).

Table 3 also shows that results are affected by whether total, fork or standard length is measured. (Standard length is the length from the tip of the snout to the notch in the caudal peduncle.) All three lengths were measured on the sample from cruise C.142. The percentage changes in fork and total lengths were closely similar but that in standard length was 0.8-1.0% greater. In terms of actual lengths, there was an average decrease of 1.1 cm in standard length but only of 0.9 cm in total and fork lengths. This would suggest that not only had the caudal fin not shrunk at all but, in fact, it had increased in length by 0.2 cm. This is a most unlikely occurrence and the results undoubtedly reflect a bias involved in shipboard measurements of either fork and total lengths or standard length of argentines.

The relationship of percentage change to initial length was examined in three batches of fish (Tables 2 and 4). Regression equations of percentage change on fish length indicated that, in one case (H.85), the change was positively related to fish length, in one (C.126) it was not affected by fish length, and in the other (C.131) it was negatively related ($P = 0.05$). The fact that fish from H.85 had been iced for 24 hours prior to freezing should not influence these results as it has already been shown that icing affected all sizes equally. Thus, there do not appear to be any consistent trends in relative length change with length of fish although under some circumstances such trends occur.

The effects of freezing on weight of argentines were determined from one sample which had been on ice 24 hours prior to weighing (H.85). After being frozen for 2 months, the weight increased on average by 0.8% (Table 5). Small fish gained more weight than large fish ($P = 0.01$).

Cod, haddock, plaice and winter flounder all lost length and weight on freezing. All four species show a slight tendency to shrink more with increase in time frozen, at least during the first 15 days. The relationship of weight loss to time frozen is more variable and does not show consistent trends (Table 6). The average losses for fish thawed after freezing for 8 days or more were:

	Length %	Weight %
Cod	2.9	0.5
Haddock	1.9	1.0
Plaice	2.1	0.3
Winter flounder	2.6	0.6

Table 6. Percentage length and weight changes in cod, haddock, plaice and winter flounder in relation to length of time frozen.

	Cod			Haddock			Plaice			Winter flounder		
Days frozen	No. of fish	% length change	% weight change	No. of fish	% length change	% weight change	No. of fish	% length change	% weight change	No. of fish	% length change	% weight change
0.5	26	-1.8	-0.2	29	-1.4	-1.0	21	-1.5	-0.8	40	-1.9	-0.2
1.5	10	-2.3	+0.1	-	-	-	-	-	-	-	-	-
8	7	-2.4	+1.1	20	-1.9	-1.4	17	-1.8	-0.5	29	-2.4	-0.4
15	-	-	-	19	-2.0	-0.6	11	-2.4	0.0	30	-2.6	-0.5
29	10	-3.1	-2.1	-	-	-	-	-	-	21	-2.3	-1.2
57	10	-3.7	-0.6	10	-1.9	-1.1	-	-	-	20	-3.0	-0.3

Table 7. Percentage length and weight changes in cod, haddock, plaice and winter flounder in relation to number of times frozen.

	Cod			Haddock			Plaice			Winter flounder		
Times frozen	No. of fish	% length change	% weight change	No. of fish	% length change	% weight change	No. of fish	% length change	% weight change	No. of fish	% length change	% weight change
1	26	-1.8	-0.2	29	-1.4	-1.0	21	-1.5	-0.8	40	-1.9	-0.2
2	8	-2.6	+0.3	10	-2.6	-3.1	21	-3.0	-2.4	30	-3.0	-0.5
3	8	-3.8	-2.6	10	-3.8	-3.5	10	-4.0	-6.6	30	-3.4	-1.9
4	7	-4.6	-3.1	-	-	-	-	-	-	20	-3.9	-4.7

Table 8. Percentage length and weight changes in cod, haddock, plaice and winter flounder on soaking in water after thawing.

	Cod			Haddock			Plaice			Winter flounder		
Hours soaking	No. of fish	% length change	% weight change	No. of fish	% length change	% weight change	No. of fish	% length change	% weight change	No. of fish	% length change	% weight change
0	28	-2.5	-2.8	57	-1.8	-0.8	29	-2.2	0.0	30	-2.6	-0.3
4	28	-2.6	+2.7	56	-2.2	+0.7	18	-2.5	+4.4	29	-2.3	+4.0
9	28	-2.6	+5.1	58	-2.4	+2.8	29	-2.6	+5.7	30	-2.3	+7.0
24	28	-2.7	+8.5	58	-2.6	+4.5	29	-2.6	+6.5	30	-2.3	+9.9

The effect of repeated freezings and thawings was tested (Table 7). All four species lost progressively more length and weight with increase in number of thawings.

The effect of leaving fish soaking in water beyond the time they were considered fully thawed was tested. Weight increased progressively up to the termination of the experiment after 24 hours (Table 8). Length changed little, decreasing slightly in all species but winter flounder.

The rapid uptake of water probably explains much of the variation in weight shown in Table 6, as a relatively short delay in weighing after thawing would alter the results considerably.

The shrinkage of cod due to rigor mortis was measured indirectly. All cod used in the above experiments were measured immediately on capture and before rigor set in. Twenty other cod were left for about 6 hours before measuring at which time they were fully in rigor. These were frozen, 10 being thawed after 12 hours, the other 10 after 8 weeks. After 12 hours frozen, cod in rigor had shrunk 0.7% compared with 1.8% for fresh cod. After 8 weeks, the figures were 1.7 and 3.7% respectively. It seems therefore that shrinkage due to rigor alone was between 1 and 2%.

Literature Review

Parker (1963), studying changes associated with anaesthesia and death in young sockeye salmon (*Oncorhynchus nerka*) immersed in water, concluded that the live weight of a fish is affected by the particular stage of osmoregulation at the time of weighing, that osmoregulation is affected by prolonged anaesthesia, and that the relative rate of water uptake is related to size of fish. He also found that water uptake continued after death, and it can be deduced from his figure that the average rate of uptake was approximately 0.7% per hour during the first 3 or 4 hours after death.

Shetter (1936) found that the average shrinkage in length of brook trout *(Salvelinus fontinalis)* due to rigor mortis was 2.6%. Burgner (1962) found a shrinkage of 2-3% in red salmon smolts *(Oncorhynchus nerka)*, and Johansen (1907) found a shrinkage of 2.2% in European plaice *(Pleuronectes platessa)* due to the same cause. Shrinkage of larval fish due to rigor mortis may be proportionally much greater than for juveniles and adults. Bal (1943) reports a shrinkage of 2 mm (22%) on death of a larval specimen of *Argentina sphyraena* L. measuring 9 mm when alive.

Preservation of *Argentina sphyraena* in 70% alcohol for 8 months produced a decrease in weight of 16% and a decrease in length of 2% (Halliday, 1966). Length changes were independent of initial length but weight changes were dependent on initial weight, small fish losing more weight than large fish.

A number of workers have considered the effects of formalin preservation (Table 9). Shrinkage in length usually occurs and this may be as great as

Table 9. Changes in length and weight of fishes due to formalin preservation.

Species	% length change	% weight change	Author	Remarks
Leucichthys artedi	-1.6	-4.1	van Oosten, 1929	Weight change from fish fixed in 4% formalin, stored in alcohol
	-0.5	-12.6	Hile, 1936	Fixed in 10% formalin, stored in 70% alcohol
	-2.7	-15.3	"	"
Salvelinus fontinalis	-5.4	-	Shetter, 1936	10% formalin
Salmo trutta	-5.2	-	"	"
Oncorhynchus nerka	-5.2	-	Burgner, 1962	"
	-6.0	-	"	"
	-4.1	+10.4	Parker, 1963	3.8% freshwater formalin
	-3.2	+10.7	"	"
Oncorhynchus gorbuscha	-4.4	+5.5	"	"
	-3.8	-4.9	"	3.8% seawater formalin
Oncorhynchus keta	-4.2	+4.5	"	3.8% freshwater formalin
	-5.4	-7.3	"	3.8% seawater formalin
Clupea harengus	-0.5	-7.8	Humphreys, 1965	Small fish 5% formalin
	-2.2	-4.2	"	Large fish "
	-0.5	-	Williamson, 1914	1% formalin
Coregonus albula	-	+2.2	Jarvi, 1920	
Pond carp	+0.7	+3.6	Amosov, 1960	4% formalin; fixed alive
	-0.1	-2.4	"	4% formalin; fixed after soaking in water
Amur wild carp	-0.8	+6.0/+8.5	"	4% formalin; fixed alive
	-0.9	-0.5	"	4% formalin; fixed after soaking in water

6.0% of the original length, depending on species. Small fish may shrink proportionally more than large fish in the cisco, *Leucichthys artedi* (Hile, 1936), in *Oncorhynchus nerka* (Burgner, 1962), and in *Clupea harengus* (Humphreys,1965). These differences due to size are not always exhibited as Parker (1963) found no differences in relative shrinkage due to size in *O. nerka.* Weight changes vary greatly from -15 to +11%. Parker *(op. cit.)* demonstrated that the direction of weight change was dependent on the ionic concentration of the formalin solution. In freshwater formalin he found that weight rapidly increased to 116-127% of initial weight, then subsequently fell to 105-111% with time. In saltwater formalin weight initially fell to 87-91% but subsequently rose to 91-95% of live weight. He also found that the larger relative weight changes were associated with the smaller fish.

Previous workers (Table 10) have found that length usually decreases, possibly as much as 1.6%, with storage on ice. Weight too usually decreases, results varying between +2 and -14%, depending on several factors. Cutting (1951) found that weight loss of iced fish on commercial trawlers depended on length of time in storage and amount of pressure exerted on them by other fish and ice laid on top of them. Cutting also noted that fish stored in boxes and thus not subjected to pressure as are those stored in pounds usually gain 1-2%, a result which agrees with that of MacCallum *et al.* (1967). The iced fish reported by Ellison (1934) to lose 8% of their weight were also exposed to pressure in the hold of a commercial vessel.

Freezing invariably causes a reduction in the length and weight of fishes (Table 11). The extent of the reduction varies greatly, depending on the techniques used in freezing and thawing and also the size of the fish. Airtight wrapping during refrigeration reduces desiccation, and thus weight loss, very markedly (Boyd *et al.*, 1967). The results of desiccation are well shown by Humphreys' (1965) results, small herring losing almost 60% of their fresh weight. Much of this weight loss is recovered when the fish are thawed in water (Anthony and Chenoweth, 1965).

Discussion

The length of a fish undergoes considerable and fairly rapid change from the time of death. In the case of weight, changes may occur before death if osmoregulation is disturbed by anaesthesia or the stress of capture. All methods of preservation alter the length and weight of fish to some degree and the magnitude of these changes varies greatly, depending on species, size, and details of preservation technique. Parker's (1963) conclusion that, for formalin preservation, "It is necessary that treatments be thoroughly described and unless these factors are standardized within any experiment, the comparison of results may simply reflect differences due treatment rather than differences in the environment." holds true for other methods of preservation. No general correction factor can be established to derive fresh lengths and weights from measurements on preserved specimens.

It does appear that icing has least effect on length and weight, changes in both frequently being less than 1% if the fish are well treated,

Table 10. Changes in length and weight of fishes due to icing.

Species	% length change	% weight change	Author	Remarks
-	-	-8.0	Ellison, 1934	
Limanda ferruginea	-1.2/-1.5	-	Lux, 1960	Based on 2 experiments
Hippoglossoides platessoides	-1.0	-	Pitt, 1967	
Pleuronectes platessa	+0.8	-3.1	Cutting, 1951	
Melanogrammus aeglefinus	+0.3/-1.6	-2.0/-14.3	"	Range } Based on 2 experiments for length and 15
" "	-	-5.1	"	Average } experiments for weight
Gadus morhua	+1.6/-1.4	+1.9/-13.2	"	Range } Based on 11 experiments for length and 85
"	-	-2.3	"	Average } experiments for weight
"	-	+0.1/+1.7	MacCallum et al., 1967	Based on 7 experiments run for 1-3 days
Eopsetta jordani	(-0.5 cm)	-	Harry, 1956	Percentages not available
Parophrys vetulus	(-0.5 cm)	-	"	" " "
Microstomus pacificus	(-0.5 cm)	-	"	" " "

Table 11. Changes in length and weight of fishes due to freezing.

Species	% length change	% weight change	Author	Remarks
Scomber scombrus	-0.9	-2.5	Williamson, 1900	
Clupea harengus	-2.4/-4.1	- 0.1/-6.0	Anthony & Chenoweth, 1965	5 experiments; thawed in water
"	-1.3/-4.5	- 6.4/-11.2	"	2 experiments; thawed in air
"	-1.0/-3.2	-11.7/-59.3	Humphreys, 1965	Not thawed; divided into size groups
"sole"	-	- 0.7/-1.1	Boyd et al., 1967	2 experiments; not thawed; cellophane wrapped and boxed
"	-	- 7.7/-7.8	"	2 experiments; not thawed; boxed only
Eopsetta jordani	(-0.5 cm)	-	Harry, 1956	Percentages not available
Parophrys vetulus	(-0.5 cm)	-	"	" " "
Microstomus pacificus	(-1.0 cm)	-	"	" " "

i.e. if pressure is kept to a minimum, and this technique is to be recommended for short-term storage. Furthermore, if frozen fish are thawed in water and weighed immediately thawing is complete, weights will usually be within 1% of the fresh value.

There is seldom any problem in obtaining accurate length measurements of fishes aboard a research vessel. An accurate weighing technique for individual, small fish at sea except under the most favourable conditions, has still to be devised. However, a combination of lengths measured at sea with weights from fish stored in ice or frozen should produce length-weight relationships accurate enough for most purposes.

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12. Cod length conversion factors for Flemish Cap (ICNAF Division 3M)[1]

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Standard, extreme total and fork lengths, as outlined in May and McCracken (1966), were measured to the nearest cm for a sample of 153 cod taken on Flemish Cap in August 1968. Least squares regression equations are shown in Fig. 1-3.

No other comparisons of standard, total and fork lengths for cod could be found in the literature. Rojo (1957), Livingstone (1957), May and McCracken (1966) and Wells (1967) made similar comparisons for haddock from different areas.

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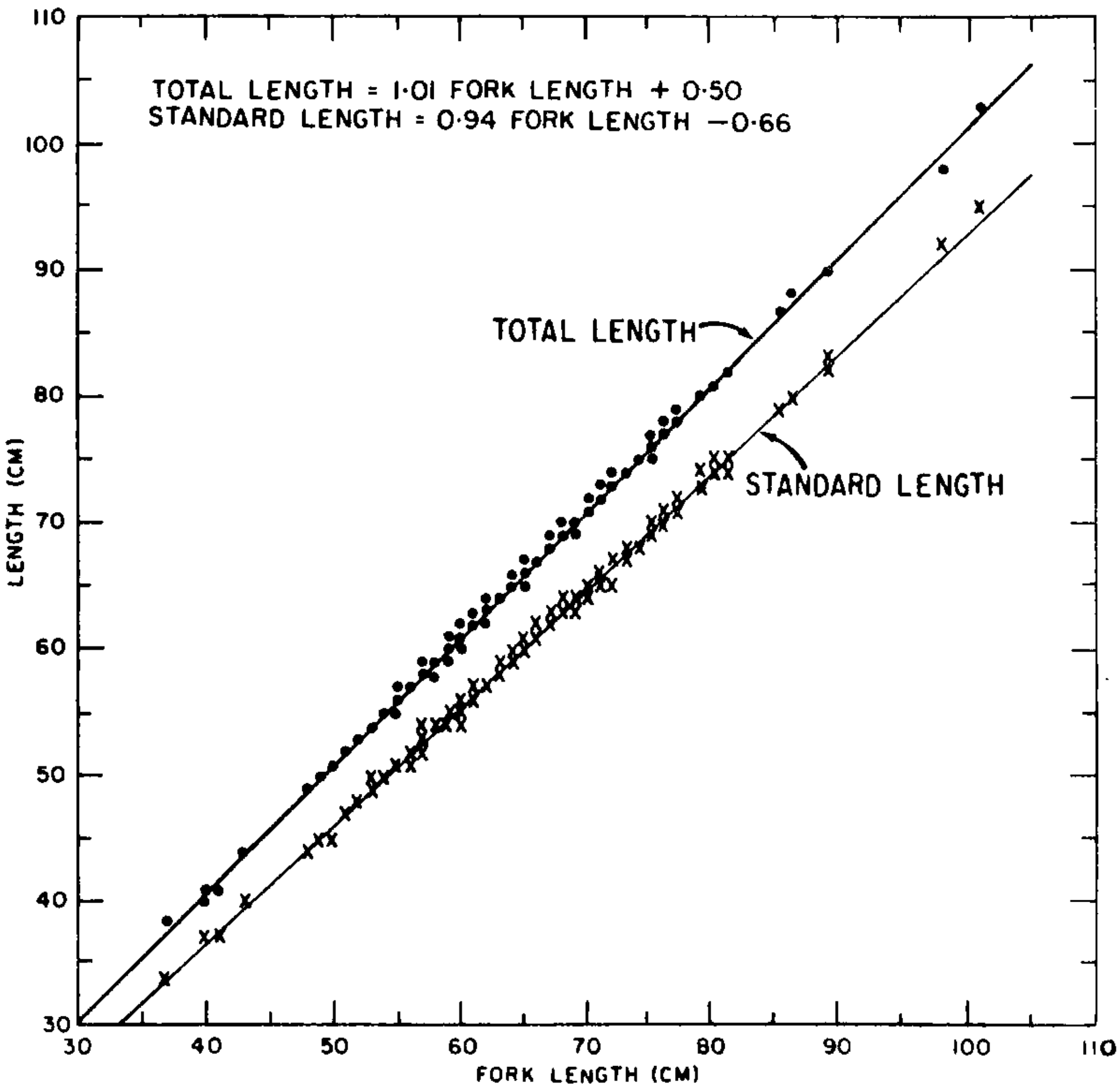

Fig. 1. Regressions of total and standard lengths on fork length of cod from Div. 3M.

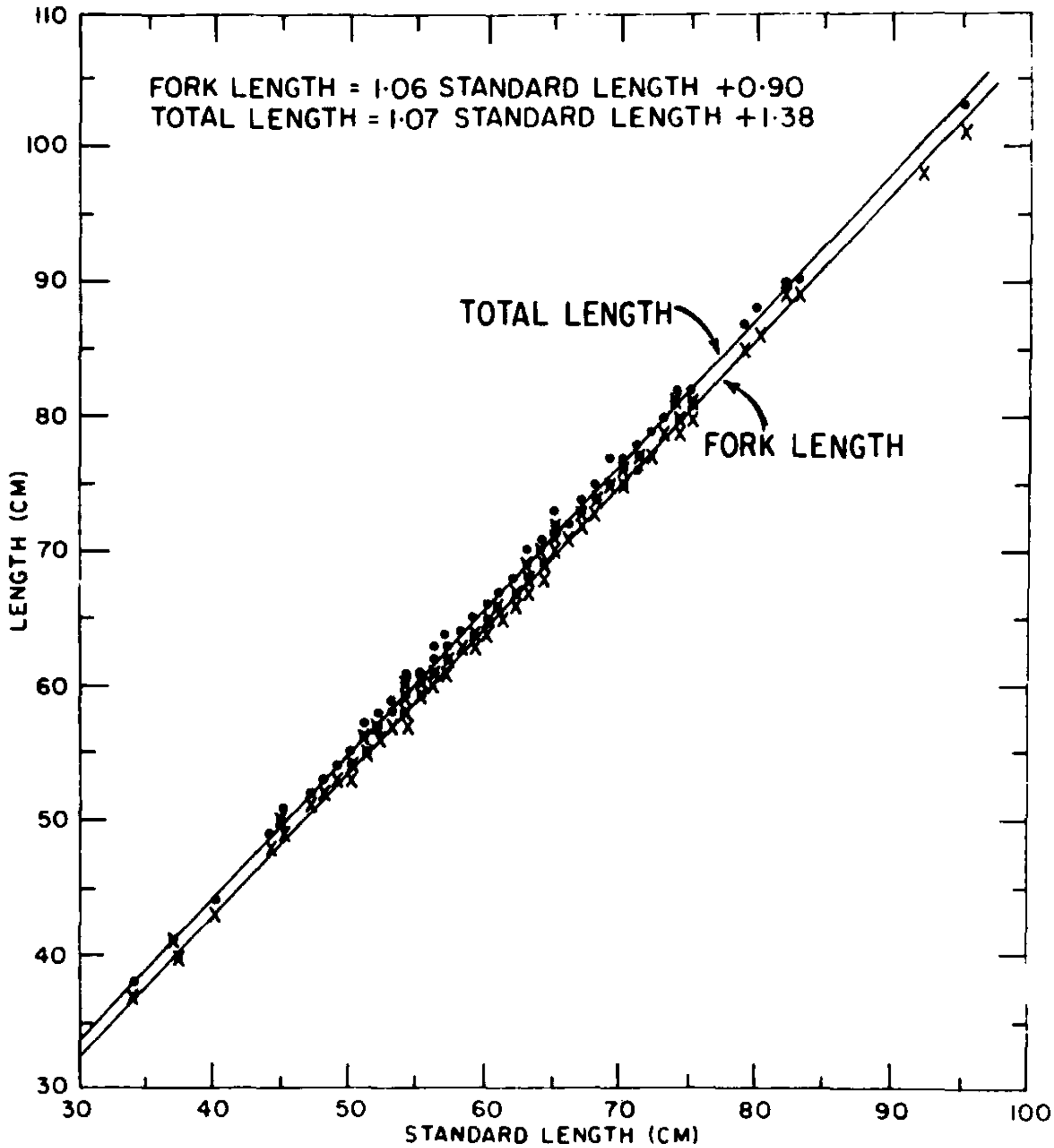

Fig. 2. **Regressions of total and fork lengths on standard length of cod from Div. 3M.**

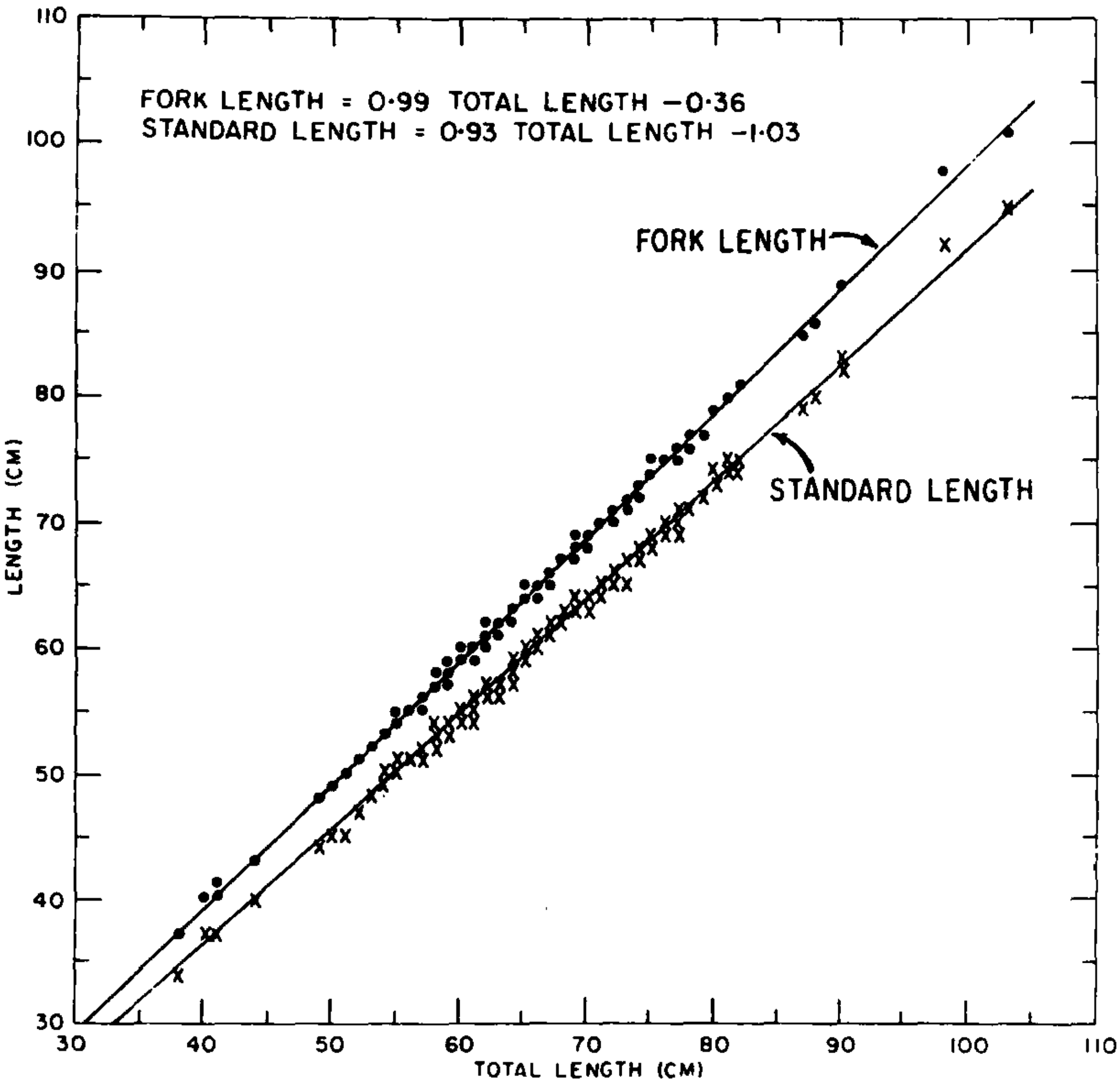

Fig. 3. Regressions of fork and standard lengths on total length of cod from Div. 3M.

13. Fork length - head girth relationships for Grand Bank and St. Pierre Bank haddock[1]

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Fork length to the nearest centimetre and head girth to the nearest millimétre were measured from haddock samples and straight lines were fitted as follows:

Period	Area	No. fish	Length-girth equation
November, 1967	Grand Bank	125	G = .54 L - 0.75
May, 1968	Grand Bank	221	G = .53 L - 1.02
November, 1967 and May, 1968	Grand Bank	346	G = .54 L - 1.05
May, 1968	St. Pierre Bank	149	G = .50 L - 1.08

For the head girth measurement in the 1967 sample, the tape was placed around the fish such that it covered the bases of the pectoral fins and the anterior edge of the tape touched the extreme posterior edge of the operculum. In the 1968 samples, a string was placed around the fish midway between the posterior edge of the operculum and the bases of the pectoral fins.

At the 0.05 level of significance, the Grand Bank samples were similar as to slope but had different elevations. This difference, although real, was considered small enough to allow the combining of data from this area. The St. Pierre Bank curve was different from the combined Grand Bank curve both as to slope and elevation.

The curves for the St. Pierre Bank data and for the combined Grand Bank data are shown in Fig. 1.

[1]submitted to the 1969 Annual Meeting of ICNAF as ICNAF Res.Doc.69/77

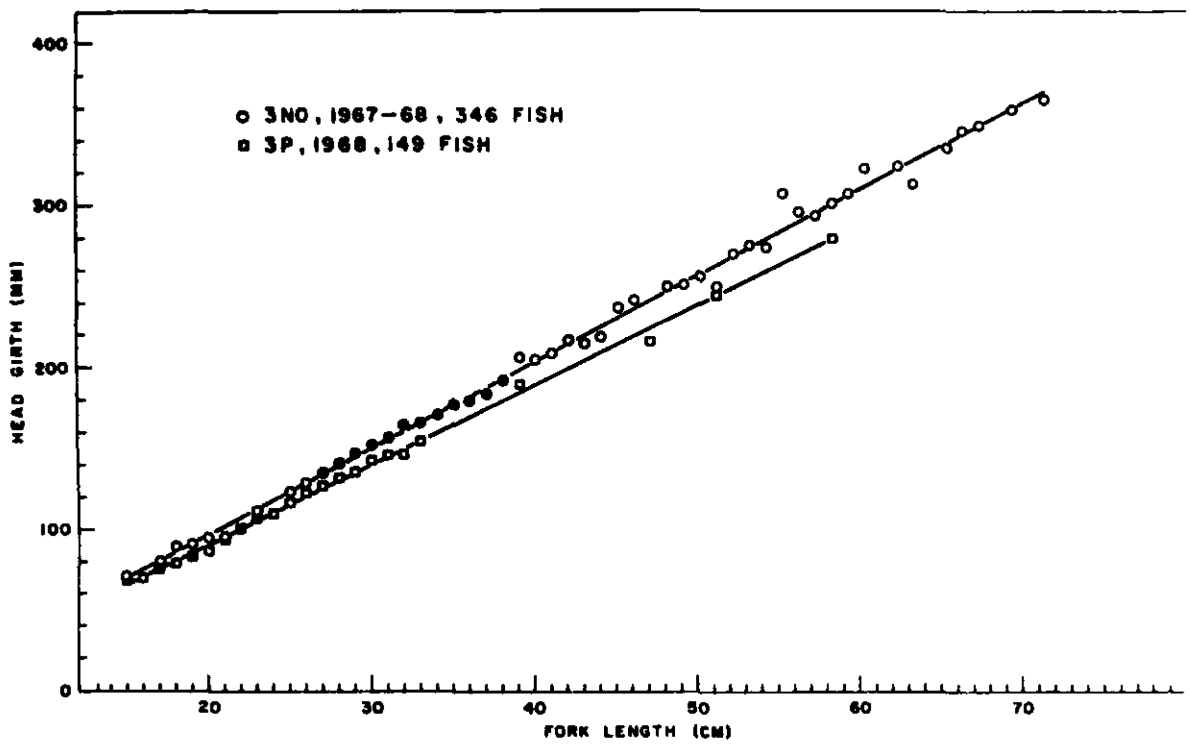

Fig. 1. Fork length - head girth relationships for Grand Bank and St. Pierre Bank haddock, 1967-68. Blacked-in symbols represent averages of ten or more fish.

14. Age-length key studies[1]

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Introduction

Preliminary analysis of the 1961-1963 data indicated that, even between keys constructed by the same country in the same month, there were statistical differences in the distribution of ages within a length group. This is not surprising when one considers the number of factors that could contribute to the overall variability within a key.

The main objective of this project was to investigate the extent to which the various age-length keys which have been compiled can satisfactorily be applied to length distributions from other areas or seasons and on the consistency of the keys compiled by different workers.

A glance at the number of factors involved would indicate that some of them could be eliminated as basis for comparisons since differences are to be expected. Hence no comparisons are being attempted between

(a) species
(b) years
(c) ICNAF Subareas

Three stages of analysis were invisaged, viz:

(a) Comparison of the mean ages within length groups and the distribution of ages within length groups;
(b) To compare the age distributions which result from applying different age-length keys to the same length distribution;

and a possible

(c) The examination of the effect of the keys on the parameters such as mortality rates and recruitment rates which are derived from the age distribution.

Limitations of the Data

Table 1 shows the distribution of the keys according to countries, species, and gear. It is obvious that no comparisons are possible for redfish, silver hake, and herring, as USSR is the only supplier of keys. The keys for

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[1] submitted to the 1969 Annual Meeting of ICNAF as ICNAF Res.Doc.69/87.

haddock came from USSR and USA, but no comparisons were attempted as the samples were taken in areas widely apart and hence any differences seemed to be due to area and season. Thus, all the following tables and results pertain to cod only.

Preliminary Selection of Keys for Comparison

As numerous factors were involved in the total variation within a key(area, depth, time of fishing, ageing technique, etc.), it was decided first to eliminate as far as possible all extraneous variations and select keys for which as many factors as possible were common. The hypothesis was that for keys produced by different countries from samples taken in the same area, time,and gear (some comparisons with different gears were attempted), the age distribution within a length group should be the same (except for sampling differences) provided the ageing techniques were not widely different. In this report, each length group within a selected key is analysed in detail.

In formulating a method of approach to tackle this problem, K.R. Allen has argued that while the length distribution within an age group may not represent a random sample, the age distribution within a length group could be considered as a random sample. A computer program was therefore developed to calculate the mean age and variance of age and per cent distribution of age within a length group, the overall mean age and mean length for the entire key, and a regression of length on age as a crude index of the growth parameter. The results for a number of keys are given in Table 2 (omitting overall mean age and mean length).

Age Composition of Hypothetical Catch

One of the major aims of this study was to investigate the extent of disagreement between the age-length keys produced by different countries. The distribution of ages within a length group was considered a reasonable criterion to test this phenomenon as assuming all other factors (area, period, and gear) being similar, the differences most likely are due to differences in ageing techniques. A length distribution (Table 3) was applied to the keys already shown in Table 2, and the results are in Table 4. It is obvious that the age distribution within selected length groups varies widely.

Comparison of year-class strength

Since the age composition of samples from catches is the main basis for arriving at such population characteristics as mortality, growth, the overall age distribution of the age-length keys was used to arrive at the year-class strength of a hypothetical population using the length sample in Table 3. The results are presented in Table 5.

Discussion and Conclusions

This study is still not conclusive evidence that the age-length keys cannot be pooled as we have not investigated the effects of pooling on the population parameters such as mortality and growth. The material available for consideration was scanty in that much of it was not comparable. However, bearing this in mind, the information presented in this report indicates in some cases that either ageing techniques or sampling methods between countries are different. This is by no means new information, but lends support to the need for an attempt to standardize ageing and sampling techniques.

Table 1. Classification of keys by country, species and gear.

Country	Species	Gear	No. of keys
USSR	Cod	Otter trawl	44
	Haddock	"	5
	Redfish	"	160
	Silver Hake	"	36
	Herring	"	5
			250
Denmark	Cod	Greenlander	27
		Longline	23
		Handline	28
		Otter trawl	13
		Shrimp trawl	1
			92
Germany	Cod	Otter trawl	71
Portugal	Cod	Otter trawl	63
U.K.	Cod	Otter trawl	14
Norway	Cod	Various	14
France	Cod	Otter trawl	9
Poland	Cod	Otter trawl	4
USA	Haddock	Various	12
USA/Canada	Haddock	Otter trawl	8
TOTAL			541

Table 1(a). Classification of keys according to gear.

Otter trawl	80%
Greenlander	5
Longline	4
Handline	5
Various	6
	100%

Table 2. Mean age for selected range of length groups in age-length keys.

Country	Area	Period & Gear	Length group	Mean age	Var. of age	Slope
Germany	1D	Jan 61	75(140)	8.6	2.69	
(1000)		OT	78(144)	9.1	3.57	
			81(120)	8.0	0.14	2.78
			84(109)	8.8	3.80	
Denmark	1D	Jan 61	75(14)	10.2	3.14	
(91)		LL	78(13)	10.1	9.14	
			81(8)	11.0	7.71	3.20
			84(4)	13.7	20.25	
Germany	1F	July 61	54(215)	5.2	0.39	
(1000)		OT	57(164)	5.4	0.66	
			60(97)	5.4	0.68	
			63(39)	6.6	1.40	4.26
Denmark	1F	July 61	54(47)	5.0	0.15	
(198)		Greenl.	57(51)	4.9	0.07	6.91
			60(42)	5.0	0.04	
			63(20)	5.2	0.30	
Portugal	3Ps	Apr 61	54(45)	5.7	0.40	
(605)		OT	57(105)	6.0	0.37	3.13
			60(50)	6.4	0.65	
			63(55)	6.6	0.79	
France	3Ps	Apr 61	54(17)	5.0	0.05	
(89)		OT	57(13)	5.9	0.07	9.05 (?)
			60(10)	6.0	0.00	
			63(10)	6.0	0.22	

(continued)

Table 2 (continued)

Country	Area	Period & Gear	Length group	Mean age	Var. of age	Slope
France	4R	Mar 61	51(29)	6.3	1.88	
(255)		OT	54(37)	6.1	0.99	
			57(28)	6.2	1.36	4.71
			60(24)	6.2	0.73	
Portugal	4R	Mar 61	51(75)	5.6	0.63	
(515)		OT	54(30)	5.8	0.49	
			57(45)	6.2	0.63	4.75
			60(25)	6.4	0.25	
France	4T	Apr 61	45(11)	5.1	0.56	
(82)		OT	48(14)	6.0	0.15	4.66
			51(7)	6.5	0.29	
			54(13)	6.5	1.27	
Portugal	4T	Apr 61	45(20)	4.5	0.26	
(563)		OT	48(60)	5.8	0.14	
			51(120)	6.7	0.53	3.42
			54(100)	6.6	1.05	
Canada (NF)	3L	Mar 61	58(63)	6.0	0.05	
(980)			61(61)	6.0	0.08	6.76
			64(40)	6.3	0.33	
			67(27)	6.6	0.69	
Portugal	3L	Apr 61	57(56)	6.0	0.00	
(567)			60(50)	6.7	2.66	3.72
			63(91)	6.0	0.44	
			66(50)	6.6	0.45	
Canada (NF)	3M	Mar 61	37(64)	3.2	0.19	
(1003)			40(62)	3.9	0.24	7.19
			43(72)	4.0	0.09	
			46(67)	4.3	0.22	
USSR	3M	Mar 61	36(5)	4.0	0.00	
(757)			39(14)	3.8	0.13	4.05
			42(37)	4.3	0.35	
			45(51)	4.8	0.54	
Denmark	Green-	Aug 62	66(20)	6.0	0.05	
(185)	land	Greenl.	69(19)	6.1	0.09	
			72(28)	6.6	1.35	3.90
			75(22)	6.7	1.16	
Germany	Green-	Aug 62	66(22)	5.3	0.22	
(1000)	land	OT	69(52)	6.0	0.00	
			72(66)	5.9	0.30	3.47
			75(108)	6.1	1.37	

(continued)

Table 2 (continued)

Country	Area	Period & Gear	Length group	Mean age	Var. of age	Slope
Portugal	1D	May 62	54(20)	4.6	0.24	
(396)		LL	57(47)	5.0	0.00	
			60(27)	5.2	0.20	4.20
			63(87)	5.0	0.07	
USSR	1D	May 62	54(70)	4.2	0.19	
(900)		OT	57(41)	4.6	0.29	
			60(67)	5.0	0.08	4.57
			63(61)	5.1	0.23	
Denmark	1B	July 62	54(29)	4.6	0.23	
(226)		HL	57(27)	4.9	0.07	
			60(32)	5.0	0.00	5.75
			63(29)	5.0	0.00	
Portugal	1B	July 62	54(30)	5.0	0.00	
(430)		LL	57(67)	4.9	0.04	4.91
			60(90)	5.0	0.03	
			63(76)	5.2	0.27	
Canada (NF)	2J	Sept 62	49(42)	5.0	0.00	
(995)			52(42)	5.4	0.25	1.27
			55(75)	6.5	1.39	
			58(99)	7.7	2.35	
USSR	2J	Oct 62	48(48)	5.7	0.34	
(300)			51(48)	6.4	3.19	2.10
			54(40)	6.8	1.45	
			57(25)	7.6	4.33	
Germany	1D	May 63	59(34)	4.3	0.22	
(1000)		OT	62(67)	5.2	0.56	
			65(67)	5.5	0.25	6.63
			68(118)	5.4	0.42	
Norway	1D	May 63	57(7)	5.0	0.33	
(49)		OT	60(7)	5.7	0.24	5.89
			63(10)	5.9	0.10	
			66(5)	6.0	0.00	
USSR	1D	Aug 63	60(13)	5.2	0.19	
(299)		OT	63(44)	5.6	0.32	
			66(38)	5.8	0.26	5.13
			69(53)	6.0	0.19	
Germany	1D	Aug 63	59(30)	5.3	0.63	
(1000)		OT	62(41)	5.3	0.69	
			65(80)	5.2	0.19	4.01
			68(103)	6.0	0.00	

(continued)

Table 2 (continued)

Country	Area	Period & Gear	Length group	Mean age	Var. of age	Slope
Norway	1D	May 63	54(5)	4.8	0.20	
(44)		LL	57(3)	5.0	0.00	
			60(4)	5.0	0.67	3.89
			63(6)	5.6	0.27	
Denmark	1D	May 63	54(23)	4.6	0.77	
(212)		HL	57(30)	4.8	0.32	
			60(26)	5.2	0.18	7.18
			63(21)	5.5	0.36	
Germany	1E	Apr 63	56(80)	5.1	0.12	
(1000)		OT	59(145)	5.2	0.20	4.56
			62(132)	5.5	0.49	
			65(162)	5.9	0.21	
Iceland	1E	Apr 63	57(32)	5.1	0.24	
(197)		OT	60(25)	5.3	0.31	5.16
			63(27)	5.7	0.43	
			66(24)	5.7	0.39	
Iceland	1E	May 63	63(21)	6.5	1.46	
(194)		OT	66(28)	6.5	0.40	
			69(19)	6.4	0.60	3.49
			72(24)	6.7	0.82	
Germany	1E	May 63	62(54)	6.0	0.18	
(1000)		OT	65(129)	6.2	0.76	
			68(208)	6.2	0.25	1.35 (?)
			71(205)	6.3	0.70	
Portugal	2J	May 63	45(23)	7.2	1.35	
(299)		OT	48(33)	8.6	5.08	
			51(40)	9.1	5.36	2.27
			54(45)	10.8	11.66	
Canada (NF)	2J	Apr 63	46(100)	6.1	0.44	
(985)			49(75)	6.2	0.41	
			52(74)	6.9	1.09	4.17
			55(93)	7.0	1.68	
USSR	2J	Apr 63	45(136)	6.8	0.49	
(944)			48(170)	7.0	0.88	
			51(141)	7.3	1.02	3.26
			54(101)	7.6	1.39	
Canada (NF)	2J	May 63	46(88)	6.0	0.18	
(1009)			49(82)	6.2	0.42	
			52(78)	6.5	0.95	4.34
			55(63)	6.7	1.90	

(continued)

Table 2 (continued)

Country	Area	Period & Gear	Length group	Mean age	Var. of age	Slope
Portugal (328)	2J	May 63	45(23)	6.5	0.44	
			48(33)	6.4	0.69	
			51(40)	7.1	1.48	2.27
			54(45)	7.2	1.35	
Canada (1003)	2J	Sept 63	46(98)	5.4	0.56	
			49(91)	5.7	0.67	
			52(57)	5.7	0.52	4.20
			55(55)	6.3	1.35	
Portugal (398)	2J	Sept 63	45(45)	5.5	0.71	
			48(54)	5.7	0.64	
			51(62)	6.2	0.98	2.67
			54(55)	6.4	1.21	
USSR (797)	2J	May 63 OT	45(92)	7.1	0.30	
			48(106)	7.6	1.16	
			51(89)	8.4	1.99	2.56
			54(107)	9.0	2.19	

NOTE: (a) Numbers in ( ) under country represent the total number of fish in the key.

(b) Numbers in ( ) on the right side of mean age represent the number of fish in the length group.

Table 3. Length distribution used on selected keys to obtain hypothetical age composition. (Sample from Canada)

Length group	Frequency	Length group	Frequency
21	39	57	869
24	76	60	616
27	216	63	399
30	435	66	274
33	591	69	183
36	1364	72	104
39	1753	75	90
42	1759	78	51
45	2405	81	28
48	2605	84	27
51	1688	87	19
54	1179	90	11
			16781

Table 4. Distribution of fish from sample in Table 3 into age groups by using different age-length keys.

Country	Factors common for countries	Length group in sample	No. of fish	4	5	6	7	8	9	10	11	12	13	14	15	16
				Distribution of ages according to age-length keys												
Germany	1D	75	90				4	70			8	4		4		
	OT	78	51					34	3	1	8			5		
	Jan	81	28				1	24	3							
	1961	84	27					21	2				2	2		
Denmark	1D	75	90					13	26	7	33		6	6		
	LL	78	51													>16
	Jan	81	28					21	9	4	13	4				
	1961	84	27					9						18		
Germany	1F	54	1179		993	164			22							
	OT	57	869		572	228	48		21							
	July	60	616		406	171	19		20							
	1961	63	399		102	72	102	123								
Denmark	1F	54	1179	25	1104	25	25									
	Greenlander	57	869	51	801	17										
	July	60	616		587	29										
	1961	63	399		319	60	20									
Portugal	3Ps	54	1179		393	655	131									
	OT	57	869		124	538	207									
	Apr	60	616		62	308	185	62								
	1961	63	399			218	145		36							
France	3Ps	54	1179		1110	69										
	OT	57	869		67	802										
	Apr	60	616			616										
	1961	63	399		40	319	40									
France	4R	51	1688	58	349	815	116	116	233							
	OT	54	1179		255	605	223	32	64							
	Mar	57	869		279	279	218	31	62							
	1961	60	616		103	282	180	51								
Portugal	4R	51	1688		788	788		113								
	OT	54	1179		393	590	197									
	Mar	57	869		193	290	386									
	1961	60	616			370	246									

(continued)

Table 4 (cont'd)

Country	Factors common for countries	Length group in sample	No. of fish	Distribution of ages according to age-length keys 4	5	6	7	8	9	10	11	12	13	14
France	4T	45	2405	219	1750	219	219							
	OT	48	2605		186	2233	186							
	Apr	51	1688			723	965							
	1961	54	1179		181	453	363	91	91					
Portugal	4T	45	24 5	1203	1202									
	OT	48	2605		434	2171								
	Apr	51	1688		141	281	1125	141						
	1961	54	1179		236	236	472	236						
Denmark	Greenland	66	274			260	14							
	Greenlander	69	183			164	19							
	Aug	72	104			67	22	7	4		4			
	1962	75	90			53	20	4	12					
Germany	Greenland	66	274		187	87								
	OT	69	183			183								
	Aug	72	104	6		92	6							
	1962	75	90		29	36	8	13	4					
Portugal	1D	54	1179	413	766									
	LL	57	869		869									
	May	60	616		456	160								
	1962	63	399		367	32								
USSR	1D	54	1179	893	286									
	OT	57	869	360	487	22								
	May	60	616	9	561	46								
	1962	63	399	7	340	39	13							
Denmark	1B	54	1179	366	813									
	HL	57	869	64	805									
	July	60	616		616									
	1962	63	399		399									
Portugal	1B	54	1179		1179									
	LL	57	869	39	830									
	July	60	616		595	21								
	1962	63	399		315	68	16							
Norway	1D	54	1179	236	943									
	LL	57	869		869									
	May	60	616	154	308	154								
	1963	63	399		133	266								

(continued)

Table 4 (cont'd)

Country	Factors common for countries	Length group in sample	No. of fish	Distribution of ages according to age-length keys									
				4	5	6	7	8	9	10	11	12	13
Denmark	1D	54	1179	615	359	154	51						
	HL	57	869	203	580	86							
	May	60	616		474	142							
	1963	63	399		209	171	19						
Portugal	2J	45	2405		209	732	1464						
	OT	48	2605		237	1263	789	316					
	May	51	1688			549	760	169	169			42	
	1963	54	1179			262	550	236	77		52		
USSR	2J	45	2405			235	1673	497					
	OT	48	2605			98	1327	885	74	172	25		25
	May	51	1688			57	398	588	322	152	95	76	
	1963	54	1179				165	309	264	286	77	33	44

Table 5. Age composition of samples in Table 3 using the keys from different countries.

Age	1961 1D Jan Germany	Denmark	1961 1F July Germany	Denmark	1961 3Ps Apr Portugal	France
3					134	
4	17	3121		839	1796	738
5	2064	168	9598	14650	2484	5453
6	1006	906	1980	755	5672	6024
7	1107	168	587	168	2484	2450
8	8742	3121	252	252	1930	1879
9	856	1983	973		1242	
10	234	536	386		553	164
11	1342	2567	554	84	134	
12	184	352	50		134	
13	285	536			134	
14	923	1983	117			
15	33	-				
>15	165	704				

Age	1961 4R Mar France	Portugal	1961 4T Apr France	Portugal	1962 * Aug Denmark	Germany	1962 1D May USSR	Portugal
3	50						17	
4	1376	1410	604	285	168	470	5554	1174
5	3222	6830	3474	1778	621	889	3625	9011
6	5655	4397	7367	3574	8877	4178	1712	3423
7	3608	1627	873	5957	2349	2081	1040	285
8	1108	638	1225	2383	537	671	705	285
9	839		201	1208	2618	5084	2903	1947
10	319		604	654	537	1275	268	-
11	386	151		839	168	67	268	-
12	50		604		537	1359	251	285
13					-	285	17	285
14					84	-	119	-
15					84	318	136	-
>15					84	84	68	-

Age	1961 3L Canada Mar.	Portugal Apr.	1961 3M Mar Canada	USSR	1962 2J Canada Sept.	USSR Oct.
1			1661	252		
2			1460	117		
3	2718		4581	923		
4	4614	436	3205	1326	134	554
5	2097	1913	2466	1879	1543	4581
6	4078	6125	17	705	2098	7317
7	570	1762	1661	5336	2517	1611
8	1057	1476	1258	4246	2919	772
9	419	1325	17	503	1947	654
10	369	1175	50	385	1661	319
11	134	1175	50	318	402	151
12	117	436	134	503	1393	100
13	117	738	17	101	-	218
14	67			34	554	151
15	34	134		17	554	50
>15	151				889	151

*Greenland

(continued)

Table 5 (cont'd).

Age	1962 1B July		1963 2J May		1963 2J May	
	Denmark	Portugal	USSR	Portugal	Norway	Denmark
3	436	218				470
4	3339	889	201	50	2282	4581
5	11276	11344	554	722	4950	5135
6	285	856	1057	3977	4195	5051
7	436	453	4447	4648	1896	1175
8	218	1006	3239	2467	369	235
9	436	654	1745	1108	755	67
10	67	336	1779	1006	1141	
11	-	100	805	889	369	
12	134	100	940	503	-	
13	-	-	453	385	-	
14	-	218	352	218	-	
15	67	336	268	268	369	
>15	-	100	1056	456	369	

Age	1963 2J Apr		1963 2J May		1963 2J Sept.	
	Canada	USSR	Canada	Portugal	Canada	Portugal
1						
2	403		638		101	34
3	772	67	571		1611	34
4	3071	1259	3088	50	5789	873
5	1963	1208	2131	722	3021	2567
6	5152	2769	5555	3977	4279	7165
7	2014	6477	2165	4648	805	3574
8	923	2450	705	2467	436	839
9	688	1074	285	1108	84	537
10	487	453	385	1007	185	201
11	352	252	369	889	101	285
12	101	167	101	503		167
13	168	151	185	386	84	117
14	117	67	67	218	17	34
15	185	34	134	268	17	168
>15	268	252	134	436	34	84

SECTION F
SELECTIVITY

15. Selectivity experiments on the Grand Bank of Newfoundland in 1967[1]

by M.J.Holden
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In November 1967 the Fisheries Laboratory, Lowestoft, chartered the side motor trawler *Ross Renown* to carry out, amongst other work, selectivity experiments on the Grand Bank of Newfoundland. Part of the charter was devoted to studying the effect of a tight topside chafer on the selectivity of a polypropylene continuous multifilament codend, and part to the comparison of the selectivity of this codend with that of one made of polypropylene split fibre.

Gear

Specifications of the gear used are given in Table 1. The topside chafer consisted of an old codend and was lashed along all four edges to the codend.

Results

These are shown in Table 2 and Fig. 1 and 2. The tight topside chafer reduced the mean selection factor by 11%; the difference was significant: $t = 7.38$, $P < 0.001$ for 12 degrees of freedom. A very similar reduction was found by Holden (1966).

The mean value of the selection factor for the polypropylene split fibre codend lay within the 95% confidence limits of that for the continuous multifilament codend. This result supports the conclusion drawn by Hylen (1969) that the selectivities of these two forms of polypropylene are the same.

References

Holden, M.J. 1966. The effect of tight topside chafers on the selectivity of manila codends. *ICES Coop. Res. Rep.*, Series B, 1966, 152-153.

Hylen, A. 1969. Selectivity experiments with a codend made of polypropylene split fibres. *ICES Coop. Res. Rep.*, Series B, 1968, 51-55.

[1]submitted to the 1969 Annual Meeting of ICNAF as ICNAF Res.Doc.69/36

Table 1. Specification of gear used.

Ship	M/T *Ross Renown*; 59.8 m overall length; 1,500 h.p.; 700 gross tons	
Gear	Small Granton trawl; 24 m headline, 16 m footrope	
Species studied	Cod	
Experimental method	Topside cover with blinders on lower side of codend	
Date	15 November 1967 to 27 November 1967	
Speed of tow	3.5 to 4.0 knots	
Type of mesh gauge	ICES; 4 kg pressure	
Cover	ICES specification	
Material	Polyethylene continuous filament	
Runnage (m/kg)	545	
R. Tex.	1838	
Braiding	Single twine	
Twine construction	Twisted	
Mesh size (mm)	70 mm	
Codends		
Material	Polypropylene continuous filament	Polypropylene split fibre
Runnage (m/kg)	201.8	161.5
R. Tex.	5012	6203
Braiding	Double	Double
Twine construction	Plaited	Twisted
Mesh size ± s.e. (mm)	(i) 116.4 ± 0.42 (St.13-27) (ii) 115.9 ± 0.36 (St.31-40)	130.6 ± 0.61
No. meshes measured	(i) 100 (ii) 125	70
Range of mesh size (mm)	(i) 110-128 (ii) 108-128	120-146
Chafer		
Material	Polyester	
Runnage (m/kg)	201.8	
R. Tex.	5000	
Braiding	Double	
Twine construction	Plaited	
Mesh size ± s.e. (mm)	112.4 ± 0.47	
No. measurements	50	
Range (mm)	110-119	

Table 2. Summary of results of selectivity experiments on the Newfoundland Grand Bank.
N.B: For grouped stations, the numbers caught are the sums of the catches.

Station no.	13	14	19	20	21	5, 10, 12	16, 17, 18	26 & 27	31	33	34	35	37	38, 39, 40	42, 43, 44, 46	47, 48, 49, 50
ICNAF region	3N	3N	3N	3N	3N	3N	3N	3L	3L	3L	3L	3L	3L	3L	3L	3L
Mesh size (mm)	116.4	116.4	116.4	116.4	116.4	116.4	116.4	116.4	115.9	115.9	115.9	115.9	115.9	115.9	130.6	130.6
Cod-end material	Polypropylene continuous multifilament								Polypropylene continuous multifilament						Polypropylene split fibre	
Chafer	YES								NO						NO	
50% point (mm)	437	414	440	445	434	442	434	448	504	482	496	465	504	485	570	561
Selection factor	3.75	3.56	3.78	3.82	3.73	3.80	3.73	3.85	4.35	4.16	4.28	4.01	4.35	4.18	4.36	4.30
Selection range (mm)	385-475	377-446	390-475	405-478	412-451	401-473	384-474	398-492	457-544	396-515	452-540	405-505	466-532	446-522	543-602	524-588
No. of cod in selection range																
Cod-end	144	53	190	63	19	37	80	61	129	648	124	398	88	59	34	51
Cover	180	44	267	72	40	56	129	83	136	1150	194	597	99	91	35	49
Total number of cod																
Cod-end	239	253	303	151	105	157	183	827	433	1574	414	708	474	552	427	471
Cover	309	87	423	216	281	167	341	139	977	2290	1122	1455	1068	1669	189	315
Catch of other species† (kg):																
Cod-end: Macrurids	300	1050	90	2750	150	210	360	-	-	-	-	60	-	-	-	-
Sebastes	60	150	60	-	-	-	30	-	-	-	-	15	30	150	105	30
Dabs	30	-	900	-	3000	1110	900	270	-	-	-	15	30	360	2460	870
Rays	-	-	-	-	-	-	-	1050	600	-	-	60	120	60	60	-
Cover: Sebastes	30	60	30	600	300	-	-	-	-	-	-	-	15	210	60	-
Dabs	-	-	15	-	-	-	15	-	-	-	-	-	15	30	225	75
Duration of tow (minutes)	160	180	195	175	180	160*	190*	185*	180	120	110	150	180	180*	200*	180*
Mean selection factor	3.75								4.22						4.33	
Variance	0.0079								0.0173						-	
Standard deviation	± 0.089								± 0.132						-	
95% confidence limits of selection factor	3.68-3.83								4.08-4.36						-	

† Macrurids = *Nezumia bairdii*; 'Dabs' = American plaice (long rough dabs), *Drepanopsetta platessoides* and Yellowtail flounders, *Limanda ferruginea*; Rays = mainly *Raja radiata*. Other main species caught: *Lycodes*, *Anarrhichas*, *Reinhardtius hippoglossoides*

* Mean values.

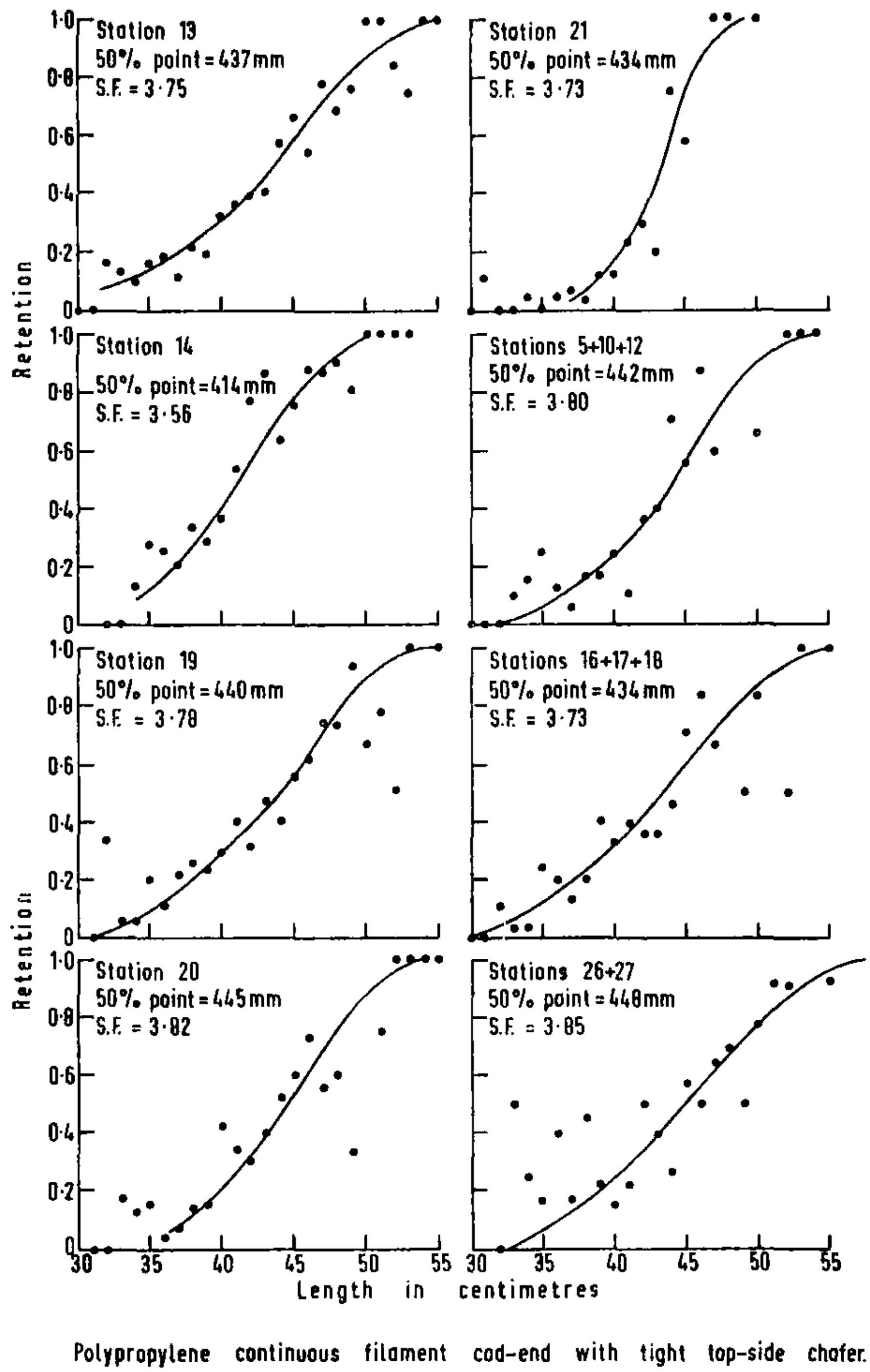
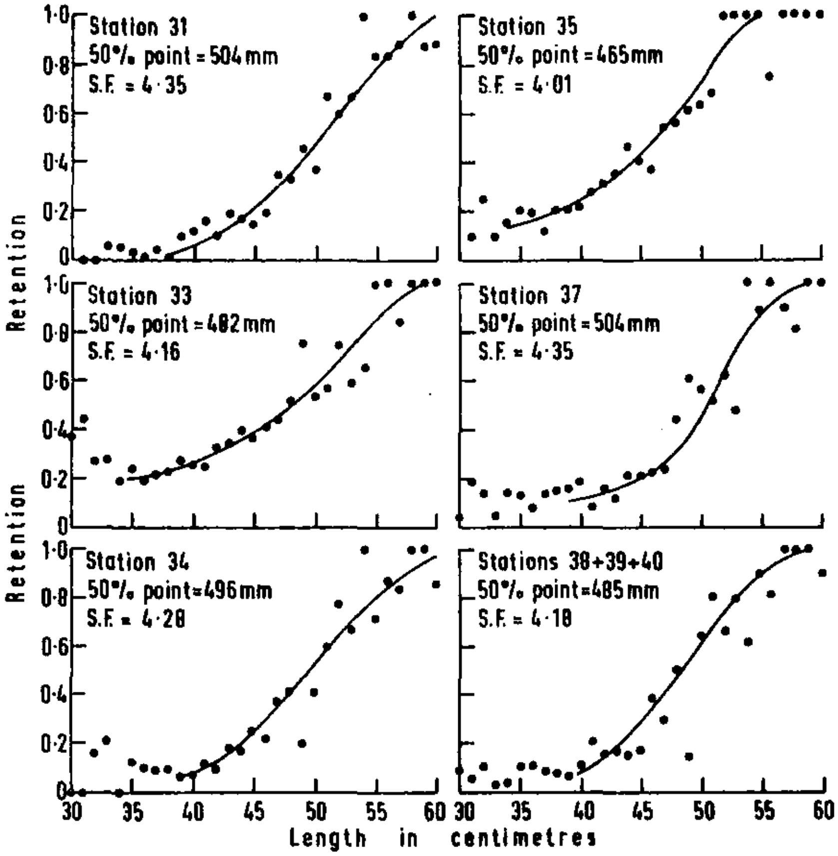
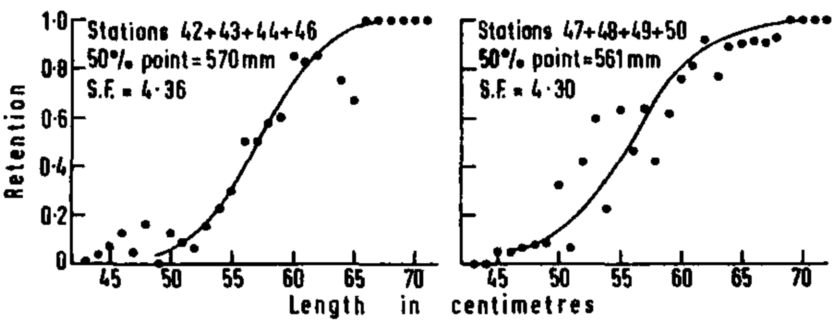


Fig. 1. Selection ogives for a polypropylene continuous multifilament codend with a tight topside chafer.



Polypropylene continuous filament cod-end without chafer.



Polypropylene split-fibre cod-end without chafer.

Fig. 2. Selection ogives for a polypropylene continuous filament codend and a polypropylene split fibre codend, both without a chafer.

SECTION G
STATISTICS

16. Summary of Statistics on Discards, 1967[1]

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ICNAF Secretariat

At its 1969 meeting, the Subcommittee on Statistics and the Standing Committee on Research and Statistics recommended:

> "that the discard portion of the summary document on discards and industrial fish be continued to be published annually in Redbook, Pt.III,..." (Redbook, 1969, Pt.I, p.48).

Statistics on species and quantities of whole fish discarded at sea in 1967 by Canada (M), Canada (N), France (M), Germany, Poland, Portugal, Spain, UK, and USA, and submitted on ICNAF Stat. Form 4, are summarized in the attached table. Denmark (G) submitted a NIL return. Iceland reported no data available. USSR reported that no whole fish are discarded at sea. Denmark (F) and Norway did not report their data. Italy did not fish in the Convention Area in 1967. In addition to its tabulated submissions Canada (M) wrote "It remains normal practice to discard 100% of all silver hake, agentine, sculpins, lumpfish, sea robins, eelpouts and dogfish. Skates are landed occasionally but are normally discarded 100%. Very few anglers are retained. Most cusk are taken on longlines with practically no discards. Atlantic halibut discards are negligible. Some attempts were made to land and market anglers but this met with little success and most would be discarded. Discards by longliners and gill netters of commercial species of groundfish is negligible. Discards of pollock, hake and cusk by otter trawlers are also low."

[1] Submitted to the 1969 Annual Meeting of ICNAF as part of ICNAF Res.Doc.69/23

Abbreviations and Symbols used
(as in latest Statistical Bulletin)

Species:	Had	-	haddock
	Red	-	redfish
	Sil	-	silver hake
	Flo	-	flounders
	Pla or (p)	-	American plaice
	Wit or (w)	-	witch
	Yel or (y)	-	yellowtail flounder
	Gro	-	groundfish
	Pol	-	pollock
	Her	-	herring
	Sha	-	sharks
	Ska	-	skates
	Sme	-	smelt
	Mix	-	mixed
	NK	-	not known
Gear:	OT	-	otter trawl
	PT	-	pair trawl
	Da.S	-	Danish seine
	Sc.S	-	Scottish seine
Tonnage Class:	1		0 - 50 GRT
	1b		26 - 50 GRT
	2		51 - 150 GRT
	3		151 - 500 GRT
	4		501 - 900 GRT
	5		901 - 1800 GRT
	6		over 1800 GRT
Country:	Can (M)	-	Canada (Maritime and Quebec)
	Can (N)	-	Canada (Newfoundland)
	Fr (M)	-	France (Metropolitan)
	Fr (SP)	-	France (St. Pierre et Miquelon)
	Ger	-	Germany
	Pol	-	Poland
	Por	-	Portugal
	Spa	-	Spain
Source of information:			
	Log	-	logbook
	Int	-	dockside interview
	Rep	-	current reports

Symbols:	...	-	not available or not reported
	-	-	magnitude known to be nil or zero
	∅	-	magnitude known to be more than zero but less than half the unit.

SUMMARY OF STATISTICS ON DISCARDS, 1967

Division	Main Species Sought	Gear and Tonnage Class	Country	Discard in Tons	COD Nominal Catch in Tons	COD Rate of Discard (%)	HADDOCK Discard in Tons	HADDOCK Nominal Catch in Tons	HADDOCK Rate of Discard (%)	REDFISH Discard in Tons	REDFISH Nominal Catch in Tons	REDFISH Rate of Discard (%)	FLOUNDERS Discard in Tons	FLOUNDERS Nominal Catch in Tons	FLOUNDERS Rate of Discard (%)	MIXED Discard in Tons	MIXED Principal Species	MIXED Nominal Catch in Tons	Rate of Discard (%)	Source of Information	Sampling Rate in %
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1B	Cod	OT 6	Fr(M)	15	4445	ø														Log	100
	Cod	OT 5	Fr(M)	130	17606	1				13	-	100	ø	-	100	10		-	100	Log	100
	Cod	OT 4-6	Ger	48	9033	1										2	NK	-	100	Rep	100
	Cod	OT 5	Spa													2	NK	-	100	Log	64
	Cod	PT 3	Spa													ø	NK	-	100	Log	80
1C	Cod	OT 5	Fr(M)	92	7170	1				4	-	100								Log	100
	Cod	OT 4-6	Ger	185	31865	1				ø	1495	ø				63	NK	-	100	Rep	100
	Cod	OT 5	Spa													7	NK	-	100	Log	64
	Cod	PT 3	Spa													3	NK	-	100	Log	80
	Cod	OT 6	Fr(M)							ø	-	100								Log	100
1D	Cod	OT 5	Fr(M)	48	10337	ø				11	-	100								Log	100
	Cod	OT 4-6	Ger	344	65324	1				11	4186	ø				76	NK	-	100	Rep	100
	Cod	OT 5	Por	2	990	ø										5				Log	100
	Cod	OT 5	Spa	2	500	ø										14	NK			Log	64
	Cod	PT 3	Spa	3	4836	ø										3		-	100	Log	80
1E	Cod	OT 5	Fr(M)	4	1194	ø														Log	100
	Cod	OT 4-6	Ger	35	22113	ø				8	2448	ø				35	NK	-	100	Rep	100
	Cod	OT 5	Spa	3	376	1										4	NK			Log	64
1F	Cod	OT 4-6	Ger	17	10167	ø				18	2817	1				14	NK	-	100	Rep	100
1B-1F	Cod	OT 4	UK													2389	Cod	10769	18	Int	100
Subarea 1				928	185956	ø				65	10946	1	ø	-	100	2627		10769	20		
Total Catches					429479			177			13210			2157							

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
2G	Cod	OT 4-6	Ger	1	239	ø														Rep	100
2H	Cod	OT 6	Fr(M)	5	250	2														Log	100
	Cod	OT 5	Fr(M)	20	795	3														Log	100
	Cod	OT 4-6	Ger	103	11069	1				14	503	3				26	NK	-	100	Rep	100
	Cod	OT 5	Por	6	1285	ø										9		-	100	Log	100
	Cod	OT 5	Spa	11	779	1										28	NK	-	100	Log	64
2J	Cod	OT 6	Fr(M)	61	5822	1				3	-	100								Log	100
	Cod	OT 5	Fr(M)	620	17794	3				107	-	100	1	-	100	3		-	100	Log	100
	Cod	OT 4-6	Ger	96	21047	ø				5	280	2				38	NK	-	100	Rep	100
	Cod	OT 6	Por	72	10332	1										60		-	100	Log	100
	Cod	OT 5	Por	360	36513	1										201		-	100	Log	100
	Cod	OT 5	Spa	245	36036	1										1111	NK	-	100	Log	64
	Cod	PT 3	Spa													2	NK	-	100	Log	80
Subarea 2				1600	141961	1				129	783	1	1	-	100	1478		-	100		
Total Catches					297809			114			17050			4774							
3K	Cod	OT 6	Fr(M)	29	4156	1														Log	100
	Cod	OT 5	Fr(M)	630	23927	3				220	-	100	1	-	100	23		-	100	Log	100
	Cod	OT 5	Por	77	9600	1										115		-	100	Log	100
	Cod	OT 5	Spa	54	9498	1										432	NK	-	100	Log	64
	Cod	PT 3	Spa													1	NK	-	100	Log	80
3L	Cod	OT 3	Can(M)	39	317	11														Log	16
	Cod	OT 4	Can(N)	81	2285	3							64(p)	572	10					Log	25
	Cod	OT 3	Can(K)	21	3175	1							6(p)	1027	1					Log	67
	Cod	OT 6	Fr(M)	69	5716	1				14	-	100								Log	100
	Cod	OT 5	Fr(M)	368	17498	2				86	-	100	ø	-	100	3		-	100	Log	100
	Cod	OT 6	Por	60	12016	ø										9		-	100	Log	100
	Cod	OT 5	Por	468	54892	1										568		-	100	Log	100
	Cod	OT 5	Spa	271	34265	1										1801	NK	-	100	Log	64
	Cod	OT 4	UK													20	Cod	979	2	Int	100
	Cod	PT 3	Spa	264	25306	1	39	830	4							725	NK	-	100	Log	80
	Pla	OT 4	Can(N)	628	3482	15							22(p)	14338	ø					Log	4
	Pla	OT 3	Can(N)	72	2372	3							555(p)	11305	5					Log	3
	Flo	OT 3	Can(M)										718	4856	13					Log	2

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
3M	Cod OT	3	Can(N)	-	45	-														Log	100
	Cod OT	6	Fr(M)	41	1258	3	1	-	100	26	-	100								Log	100
	Cod OT	5	Fr(M)	31	5499	5				164	-	100								Log	100
	Cod OT	6	Por	18	395	4										6		-	100	Log	100
	Cod OT	5	Por	43	10333	6										77		-	100	Log	100
	Cod OT	5	Spa	16	2432	1										150	NK	-	100	Log	64
	Cod OT	4	UK													34	Cod	708	5	Int	100
	Cod PT	3	Spa													54	NK	-	100	Log	80
3N	Cod OT	6	Fr(M)	125	1141	10														Log	100
	Cod OT	5	Fr(M)	104	720	13				1	-	100								Log	100
	Cod OT	6	Por	60	1886	3														Log	100
	Cod OT	5	Por	267	6085	4										26		-	100	Log	100
	Cod OT	5	Spa	198	9284	2										298	NK	-	100	Log	64
	Cod PT	3	Spa	606	40552	1	53	1323	4							624	NK	-	100	Log	80
	Pla OT	3	Can(X)	-	496	-	-	27	-				372(p)	6276	6					Log	8
	Flo OT	3	Can(M)										433	2560	14					Log	1
3O	Cod OT	5	Spa	6	187	3										9	NK	-	100	Log	64
	Cod PT	3	Spa	172	27925	1	5	832	6							712	NK	-	100	Log	80
	Pla OT	4	Can(N)										387(p)	608	39					Log	4
	Pla OT	3	Can(N)	-	196	-							-	2004	-					Log	2
	Wit OT	4	Can(N)	8	75	10														Log	1
3Pn	Cod OT	6	Fr(M)							4	-	100								Log	100
	Cod OT	5	Fr(M)	53	5351	1				53	-	100	1	-	100					Log	100
	Cod OT	5	Por	43	1273	3										77		-	100	Log	100
	Cod OT	5	Spa	6	2479	2										9	NK	-	100	Log	64
	Cod PT	3	Spa													1	NK	-	100	Log	80
	Red OT	4	Can(N)	-	1	-				-	42	-	-	5	-					Log	11
	Red OT	1-3	USA	4	-	100														Int	33

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
3Ps	Cod	OT 3	Can(M)	282	554	34														Log	16
	Cod	OT 4	Can(N)	10	803	1				19	34	4	6	154	-					Log	6
	Cod	OT 3	Can(N)	-	1715	-							-	273	-					Log	100
	Cod	OT 6	Fr(M)							4	-	100								Log	100
	Cod	OT 5	Fr(M)	17	3032	2	2	-	100	111	-	100	ø	-	100					Log	100
	Cod	OT 6	Por	6	182	3										24		-	100	Log	100
	Cod	OT 5	Por													15		-	100	Log	100
	Cod	OT 5	Spa	1	732	ø										54	NK	-	100	Log	64
	Cod	PT 3	Spa	95	20120	ø	19	551	3							431	NK	-	100	Log	80
	Red	OT 4	Can(N)	-	86	-	-	152	-				-	65	-					Log	25
	Red	OT 4	Can(N)	-	19	-	-	3	-				-	77	-					Log	14
	Pla	OT 4	Can(N)	23	74	24							-	741	-	-	-	-	-	Log	4
	Pla	OT 3	Can(N)	3	137	2	-	77	-	-	29	-	43	724	-	-	-	-	-	Log	46
	Wit	OT 4	Can(N)	2	ø	100	4	28	12	-	9	-				37	Wit	122	23	Log	11
Subarea 3				5371	353572	1	123	3823	3	702	114	86	2608	45585	5	6335		1809	78		
Total Catches					720604			11542			89057			150813							
4R	Cod	OT 3	Can(M)	169	2335	7														Log	9
	Cod	OT 6	Fr(M)							35	-	100	ø	-	100					Log	100
	Cod	OT 5	Fr(M)	152	7528	2	1	1	50	148	-	100	ø	-	100					Log	100
	Cod	OT 6	Por	6	432	1										17		-	100	Log	100
	Cod	OT 5	Por	14	5748	ø										33		-	100	Log	100
	Cod	OT 5	Spa	8	3806	ø										57	NK	-	100	Log	64
	Red	OT 3	Can(M)							86										Log	1
	Red	OT 4	Can(N)	-	64	-				-	567	-	-	3	-					Log	20
	Red	OT 1-3	USA													18	Cod	-	100	Int	33
4S	Red	OT 1-3	USA	4	-	100														Int	33
4T	Cod	OT 3	Can(M)	188	2846															Log	21
	Cod	OT 2	Can(M)	4	2582	ø														Log	72
	Cod	OT 1b	Can(M)	312	5998	5														Log	4
	Cod	OT 5	Fr(M)	10	481	2				ø	-	100								Log	100
	Cod	OT 5	Spa													14	NK	-	100	Log	64
	Cod	PT 3	Spa	ø	443	ø	ø	9	4							6	NK	-	100	Log	80
	Flo	OT 3	Can(M)										44	555	7					Log	22
	Flo	OT 2	Can(M)										107	889	10					Log	8
	Flo	OT 1b	Can(M)										587	2333	20					Log	10
	Flo	Da.S 1b	Can(M)										164	1680	9					Log	ø

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
4Vn	Cod	OT 3	Can(M)	147	2883	5														Log	11
	Cod	OT 3	Can(N)	-	97	-				-	9	-								Log	1
	Cod	OT 6	Fr(M)							ø	-	100								Log	100
	Cod	OT 5	Fr(M)	12	1229	1				2	-	100								Log	100
	Cod	OT 5	Spa	4	1450	ø										82	NK	-	100	Log	64
	Cod	PT 3	Spa	ø	1340	ø										19	NK	-	100	Log	80
	Cod	Sc.S 2	Can(M)	7	100	7														Log	28
	Red	OT 4	Can(N)							-	311	ø	-	26	-					Log	17
	Red	OT 1-3	USA													27	Sme	-	100	Int	33
	Pla	OT 4	Can(N)	10	1	9				-	-	-				3	Wit	1	75	Log	3
	Flo	OT 2	Can(M)										11	211	5					Log	25
	Flo	Da.S 1b	Can(M)										106	509	17					Log	4
4Vs	Cod	OT 2	Can(M)	4	608	1														Log	72
	Cod	OT 5	Fr(M)	1	45	2				3	-	100								Log	100
	Cod	OT 5	Spa													13	NK	-	100	Log	64
	Cod	PT 3	Spa	47	19103	ø	42	838	5							603	NK	-	100	Log	80
	Red	OT 3	Can(N)										-	50	-					Log	25
	Flo	OT 3	Can(M)										336	9314	3					Log	1
	Flo	OT 2	Can(M)										57	129	31					Log	47
	Flo	Da.S 1b	Can(M)										7	90	7					Log	16
4W	Cod	OT 3	Can(M)	151	3503	4														Log	2
	Cod	PT 3	Spa	125	14748	1	49	1046	4							436	NK	-	100	Log	80
	Red	OT 1-3	USA													7	Sha	-	100	Int	33
	Flo	OT 3	Can(M)										226	1129	17					Log	1
	Flo	Sc.S 2	Can(M)										9	32	22					Log	31
4X	Cod	OT 3	Can(M)	269	4434	6														Log	ø
	Cod	PT 3	Spa	5	2536	ø	7	78	8							66	NK	-	100	Log	80
	Had	OT 3	Can(M)				204	8867	2											Log	1
	Had	OT 2	Can(M)				1026	7175	13											Log	ø
	Had	OT 1-3	USA				1	4194	ø											Int	67
	Red	OT 1-3	USA													25	811	1	96	Int	33
Subarea 4				1649	84340	2	1330	22208	6	274	887	24	1654	16950	9	1426		2	100		
Total Catches					194447			48572			88280			40861							

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
5Y	Red	OT 1-3	USA													20	Ska	3	87	Int	33
5Z	Cod	PT 3	Spa	149	14730	1	142	1355	9							260	NK	-	100	Log	80
	Had	OT 3	Can(M)				783	7051	10											Log	1
	Had	OT 1-3	USA				12	20555	ø											Int	67
	Flo	OT 1-2	USA										11274(y)	17087	40					Int	9
	Her	OT 4-6	Ger													4290	Her	28171	14	Rep	100
	Her	OT 4	Pol	3	-	100										150	Her	26928	1	Int	33
Subarea 5				152	14730		937	28961	3				11274	17087	40	4720		55102	8		
Total Catches					42310			56964			10857			48676							
A. Discards																					
Subarea 1				928	185580	ø				65	10946	1	ø	-	100	2627		10769	20		
Subarea 2				1600	141961	1				129	783	1	1	-	100	1478		-	100		
Subarea 3				5371	353572	1	123	3823	3	702	114	86	2608	45585	5	6335		1809	78		
Subarea 4				1649	84340	2	1330	22208	6	274	887	24	1654	16950	9	1426		2	100		
Subarea 5				152	14730	1	937	28961	3				11274	17087	40	4720		55102	9		
Convention Area				9700	780183	1	2390	54992	4	1170	12730	8	15537	79622	16	16586		67682	20		
Total Catches					1684649			117369			218454			247281							

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
B. Industrial Fish																					
1B	Cod	OT 4-6	Ger	1482	9033	16										87	NK	-	100	Rep	100
1C	Cod	OT 4-6	Ger	2824	31865	9				27	1495	2				351	NK	-	100	Rep	100
1D	Cod	OT 4-6	Ger	7000	65324	11				165	4186	4				726	NK	-	100	Rep	100
1E	Cod	OT 4-6	Ger	656	22113	3				87	2448	4				271	NK	-	100	Rep	100
1F	Cod	OT 4-6	Ger	581	10167	6				135	2817	5				201	NK	-	100	Rep	100
2G	Cod	OT 4-6	Ger	9	239	4										2	NK	-	100	Rep	100
2H	Cod	OT 4-6	Ger	803	11069	7				253	503	50				74	NK	-	100	Rep	100
	...	OT 6	Pol	100	8504	1														Int	33
2J	Cod	OT 4-6	Ger	1758	21047	8				23	280	8				171	NK	-	100	Rep	100
	...	OT 6	Pol	145	28592	1				40	2659	2								Int	33
3K	Cod	OT 4-6	Ger	14	247	6										2	NK	-	100	Rep	100
3L	Cod	OT 4-6	Ger	98	906	11				7	68	10				14	NK	-	100	Rep	100
	...	OT 6	Pol	25	5849	ø							10	3644	ø					Int	33
3N	...	OT 6	Pol	35	3255	1				28	3371	1								Int	33
5Z	Her	OT 4-6	Ger													4060	Her	28171	13	Rep	100
	Her	OT 6	Pol	15	-	100				3	155	2				155	Her	10749	1	Int	33
1-5	Cod	OT 5	Por	645	127653	1														Log	100
Convention Area				16190	346223	5				768	17982	4	10	3644	ø	6114		38920	16		
Total Catches					780183			117369			218454			247281							

17. Northwest Atlantic Statistical Area

FAO Area Fishing 21[1]

compiled by
the Secretary
Coordinating Working Party on Atlantic Fishery Statistics
FAO Department of Fisheries

1. GENERAL

1.1 The "Northwest Atlantic Statistical Area" covers (a) the ICNAF Convention Area, (b) adjacent waters and (c) adjacent territorial waters.

1.2 It represents Statistical Area 21 in the FAO International Statistical Classification of Fishing Areas.

2. DEFINITION OF THE "NORTHWEST ATLANTIC STATISTICAL AREA" (FAO FISHING AREA 21)

2.1 The Northwest Atlantic Statistical Area includes:

(a) The ICNAF Convention Area: this is defined as all waters, except territorial waters, bounded by a line drawn as follows:

From a line beginning at a point on the coast of Rhode Island in 71°40' west longitude; thence due south to 39°00' north latitude; thence due east to 42°00' west longitude; thence due north to 59°00' north latitude; thence due west to 44°00' west longitude; thence due north to the coast of Greenland; thence along the west coast of Greenland to 78°10' north latitude; thence southward to a point in 75°00' north latitude and 73°30' west longitude; thence along a rhumb line to a point in 69°00' north latitude and 59°00' west longitude; thence due south to 61°00' north latitude; thence due west to 64°30' west longitude; thence due south to the coast of Labrador; thence in a southerly direction along the coast of Labrador to the southern terminus of its boundary with Quebec; thence in a westerly direction along the coast of Quebec, and in an easterly and southerly direction along the coasts of New Brunswick, Nova Scotia, and Cape Breton Island to Cabot Strait; thence along the coasts of Cape Breton Island, Nova Scotia, New Brunswick, Maine, New Hampshire, Massachusetts, and Rhode Island to the point of beginning.

(b) The waters of the Northwest Atlantic bounded by a line beginning at a point on the coast of Rhode Island in 71°40' west longitude; thence due south to 39°00' north latitude; thence due east to 42°00' west longitude; thence due south to 35°00' north latitude; thence due west to the coast of North America; thence northward

[1] submitted to the 1969 Annual Meeting of ICNAF as ICNAF Res.Doc.69/26 (also FAO Fisheries Circular No.235, April 1969)

along the east coast of Hatteras Island, past Oregon Inlet along the coasts of North Carolina, Virginia, Maryland, Delaware, New Jersey, New York, Connecticut and Rhode Island to the point of beginning.

(c) All territorial waters bordering on the ICNAF Area (defined in (a) above, and on the area defined in (b) above).

3. DESCRIPTION OF THE SIX SUBAREAS OF THE NORTHWEST ATLANTIC STATISTICAL AREA

The Subareas of the Northwest Atlantic Statistical Area are as follows:

Subarea 1 - That portion of the Convention Area which lies to the north and east of a rhumb line from a point in 75°00' north latitude and 73°30' west longitude to a point in 69°00' north latitude and 59°00' west longitude; east of 59°00' west longitude; and to the north and east of a rhumb line from a point in 61°00' north latitude and 59°00' west longitude to a point in 52°15' north latitude and 42°00' west longitude.

Subarea 2 - That portion of the Convention Area lying to the south and west of Subarea 1 defined above and to the north of the parallel of 52°15' north latitude.

Subarea 3 - That portion of the Convention Area lying south of the parallel of 52°15' north latitude; and to the east of a line extending due north from Cape Bauld on the north coast of Newfoundland to 52°15' north latitude; to the north of the parallel of 39°00' north latitude; and to the east and north of a rhumb line extending in a northwesterly direction which passes through a point in 43°30' north latitude, 55°00' west longitude, in the direction of a point in 47°50' north latitude, 60°00' west longitude, until it intersects a straight line connecting Cape Ray, on the coast of Newfoundland, with Cape North on Cape Breton Island; thence in a northeasterly direction along said line to Cape Ray.

Subarea 4 - That portion of the Convention Area lying to the west of Subarea 3 defined above, and to the east of a line described as follows: beginning at the terminus of the international boundary between the United States of America and Canada in Grand Manan Channel, at a point in 44°46' 35.34" north latitude, 66°54' 11.23" west longitude; thence due south to the parallel of 43°50' north latitude; thence due west to the meridian of 67°40' west longitude; thence due south to the parallel of 42°20' north latitude; thence due east to a point in 66°00' west longitude; thence along a rhumb line in a southeasterly direction to a point in 42°00' north latitude, 65°40' west longitude; thence due south to the parallel of 39°00' north latitude.

Subarea 5 - That portion of the Convention Area lying west of the western boundary of Subarea 4 defined above.

Subarea 6 - The waters of the Northwest Atlantic bounded by a line beginning at a point on the coast of Rhode Island in 71°40' west longitude; thence due south to 39°00' north latitude; thence due east to 42°00' west longitude; thence due south to 35°00' north latitude; thence due west to the coast of North America; thence northward along the east coast of Hatteras Island, past Oregon Inlet along the coasts of North Carolina, Virginia, Maryland, Delaware, New Jersey, New York, Connecticut, and Rhode Island to the point of beginning.

4. BREAKDOWN OF THE NORTHWEST ATLANTIC STATISTICAL AREA INTO SUBAREAS AND DIVISIONS (ICNAF SUBAREAS AND DIVISIONS)

ICNAF No.	FAO Code No.
NORTHWEST ATLANTIC STATISTICAL AREA	21.0.0
Subarea 1	21.1.0
Division 1A	21.1.1
Division 1B	21.1.2
Division 1C	21.1.3
Division 1D	21.1.4
Division 1E	21.1.5
Division 1F	21.1.5
Division(s) 1NK	21.1.9
Subarea 2	21.2.0
Division 2G	21.2.1
Division 2H	21.2.2
Division 2J	21.2.3
Division(s) 2NK	21.2.9
Subarea 3	21.3.0
Division 3K	21.3.1
Division 3L	21.3.2
Division 3M	21.3.3
Division 3N	21.3.4
Division 3O	21.3.5
Division $3P_n$	21.3.6
Division $3P_s$	21.3.7
Division(s) 3NK	21.3.9

<u>Subarea 4</u>	21.4.0
Division 4R	21.4.1
Division 4S	21.4.2
Division 4T	21.4.3
Division $4V_n$	21.4.4
Division $4V_s$	21.4.5
Division 4W	21.4.6
Division 4X	21.4.7
Division(s) 4NK	21.4.9
<u>Subarea 5</u>	21.5.0
Division 5Y	21.5.1
Division $5Z_e$	21.5.2
Division $5Z_w$	21.5.3
Division(s) 5NK	21.5.9
<u>Subarea 6</u>	21.6.0
Division 6A	21.6.1
Division 6B	21.6.2
Division 6C	21.6.3
Division 6D	21.6.4
Division 6E	21.6.5
Division 6F	21.6.6
Division 6G	21.6.7
Division 6H	21.6.8
Division(s) 6NK	21.6.9

SECTION H
TRAWL SURVEYS

18. Results of a Trawl Survey carried out on the Scotian Shelf and Georges Bank in July-August 1968[1]

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Introduction

The Scotian Shelf and Georges Bank are among the most important fishing areas of the world. In recent years there has been a marked decrease in the abundance of some species which have provided major fisheries. Cooling of the water could be the main reason for the decrease in abundance of one species and at the same time it could provide favourable conditions for reproduction of another species. Furthermore, there are some data, which indicate that the waters on the Scotian Shelf have been warming in the last two years. This could somehow, affect the spawning intensity in the area. This situation must be investigated to obtain the pre-requisites for rational exploitation of fishing resources on the Scotian Shelf within the next few years.

Materials and Methods

To obtain data on the distribution and abundance of all the fishes caught, experimental trawling surveys were carried out in July-August 1968. The operations at sea lasted for 35 days and 200 trawl hauls were made (Fig. 1). Where possible standard stations were chosen as haul locations. In locations with a rough ground, bottom suitable for trawling was chosen. The gear used was a 27.1 m herring trawl without rollers. The duration of each hauling was 30 min., the speed was 3.5 knots.

Catches were processed on deck according to the methods used in the joint USSR-USA groundfish surveys. The calculation of mean catches per haul and the compilation of length frequency distribution for each species for each of the three areas (I, II and III) investigated (Fig. 1) which coincided generally with ICNAF Div. 4W, 4X, 5Z, were carried out in the laboratory. Zones of concentrations of various density were determined by interpolation for silver hake, plaice, yellowtail flounder and rays (*Raja* spp.).

The area of each zone and the area covered by the trawl during each haul was then calculated. The latter was estimated using an average of 15 m for the mouth opening of the trawl (the parameters of trawl were estimated with the help of an electronic device).

[1] Submitted to the 1969 Annual Meeting of ICNAF as ICNAF Res.Doc.69/52

Abundance indices for the above-mentioned species were then estimated. The assessment of pure stock (approximate, of course) was obtained with the help of the coefficients given by Edwards (1968)[1] with some variations. Thus, in all the cases, the area-seasonal coefficient was equal to 1, because the survey was made in one season, and on the Scotian Shelf it covered the whole habitat of the silver hake, flatfishes and rays of this area. The difference in catchability between the Soviet 27.1m trawl and the Yankee trawl calculated according to the data of the joint survey in autumn 1967, was also taken into account. For the flatfishes, the coefficients of catchability and availability for the Soviet trawl were the same as for the Yankee trawl. For the rays, the catchability of the Soviet trawl was 5 times greater than that of the Yankee trawl, and for silver hake, it was 3.6 times greater. The coefficients of catchability for rays and silver hake were increased accordingly.

The density of concentrations and the contribution of each species in the catches were recorded as mean catches per haul and as a percentage of the biomass of all the species in the total catch taken from each of the areas investigated.

The results of investigations

Results of investigations of the distribution and abundance of fishes and squids occurring in the catches during the survey are described briefly in this section. Since the gear used in bottom fishing was the 27.1m herring trawl, the most reliable data were obtained for the bottom and near-bottom species, first of all for flatfishes and rays.

(a) The distribution of bottom and near-bottom species

Plaice occurred at depths of 40–200 m at 2° - 5°C and appeared to be the most abundant of the flatfishes on the Scotian Shelf. Yellowtail flounder was caught at 35–85m in a temperature range of 4° - 11°C. The distribution of these species is shown in Fig.2-7. Witch was extremely scarce everywhere and, unlike the other flatfishes, it occurred at great depths (145–215m) in water temperatures of 3° - 9°C.

The data in Tables 1 and 2 show that Area 1 (ICNAF Div.4W) has the greatest abundance of plaice and yellowtail flounder when compared with all the areas investigated. The share of these species by weight was more than 10% of total catch, although in Areas II and III (4X and 5Z) it was 1.3% and 3%, respectively. The abundance of these species decreases sharply on Browns Bank (4X) and increases again on Georges Bank (5Z). Witch, unlike plaice and yellowtail flounder, is more abundant in Area II than in Area I. Such distribution of witch is caused by biological peculiarities, in particular, its deep habitat and, consequently, by the distinct requirements to bottom contour and to the character of bottom sediments.

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[1] The analogous calculations appeared to be impossible for other species due to the lack of data on comparative catchability of the Yankee trawl and the Soviet 27.1m herring trawl.

Table 1. Mean catch per haul (30 min.) by species and areas

Species	Areas		
	I	II	III
	kg/number of fish	kg/number of fish	kg/number of fish
Atlantic herring	38.37/149	16.41/60	44.30/253
Silver hake	4.68/69	7.26/36	22.53/144
Redfish	18.09/144	7.77/50	3.60/13
Haddock	3.74/16	17.00/19	8.24/4
Cod	2.43/4	16.55/7	8.45/4
Argentine	1.77/11	17.07/83	-
Red hake	0.08/1	0.20/1	3.00/15
Plaice	7.79/31	1.41/5	1.54/3
Yellowtail flounder	5.45/18	0.21/1	3.11/12
Witch	0.62/2	1.20/3	1.37/2
Longhorn sculpine	0.37/1	0.37/2	0.95/6
Butterfish	-	-	7.60/69
Rays *(Raja)*	11.82	4.45	13.7
Spiny dogfish	-	0.74/1	19.23/17
Other fishes	9,95	5.07	16.10
Squids	23.51/226	30.77/195	0.31/2

Table 2. Percent ratio of biomass of various species in catches

Areas	I	II	III
Species	%	%	%
Atlantic herring	30.0	12.9	28.6
Silver hake	3.7	5.7	14.7
Redfish	14.0	6.1	2.3
Haddock	3.1	13.4	5.3
Cod	2.0	13.1	5.4
Argentine	1.4	13.4	-
Red hake	0.1	0.2	1.9
Plaice	6.0	1.1	1.0
Yellowtail flounder	4.3	0.2	2.0
Witch	0.5	0.9	0.9
Longhorn sculpin	0.3	0.3	0.6
Butterfish	0	-	4.9
Rays *(Raja)*	9.0	3.5	8.9
Spiny dogfish	-	0.7	12.4
Other fishes	7.6	4.3	10.9
Squids	18.0	24.2	0.2
	100.0	100.0	100.0

The catches included several species of rays (big skate, *Raja erinocea, Raja eglanteria, Raja radiata, Raja laevis*) combined into one group for convenient calculation of total biomass. The survey data are in absolute agreement with Edward's opinion (1968) on the general occurrence and rather uniform distribution of rays which seldom form dense concentrations in spite of their considerable biomass. The distribution of rays is shown in Fig. 8-10. The data given in Tables 1 and 2 show an interesting similarity in abundance of rays in Areas I and III (about 9% of total catch) and a sharp decrease in abundance in Area II (3.5%).

When considering the distribution of flatfishes and rays in all areas we can suppose that the environmental conditions for some bottom species are less favourable in Area II than in adjoining waters. This is probably related to the bottom contour and the character of bottom sediments. However, it can be connected with other factors, and not with temperature. According to Bigelow and Schroeder (1953) most species of rays occur in a wide temperature range (from 0^{o} to 16^{o}C).

For Gadidae, in Areas I and III, the most abundant species is silver hake. Its abundance increases in a western direction (Tables 1 and 2). A high mean catch of silver hake from Area II (higher than that from the Div.1) can be attributed, not to its numerical predominance, but to its greater mean weight. In Area I the bulk of catches consists of fry 12-13cm in length. Lost abundance of silver hake in Area II is also suggested by the difference between areas occupied by the concentrations (Fig. 11-13). In general, the results of the survey indicate an extremely low abundance of silver hake on the Scotian Shelf as compared to that on Georges Bank.

Such a distribution however, was not always characteristic of silver hake. Only 6-7 years before the period of cooling hake was the most abundant of the species in Area I, and its stock was probably much poorer than the stock on Georges Bank in that time.

In subsequent years the commercial stock of hake in this area was recruited by poor year-classes. (Konstantinov and Noskov, 1966). However, as mentioned above, a great number of young fish of the 1967 year-class was found here in the summer of 1968. Yearlings were confined to depths of 160-200 m in temperatures of 5.5° - 9°C. Catches of this year-class were 1500 fish per haul, mean catch for a whole area was 61 specimens per haul (3929 specimens in the area).

The abundance of young fish coincident with the warming effect (see above) suggests the beginning of a recovery of hake abundance in the Area I. Probably this process did not concern Area II where mean catch of the 1967 year-class was only 8 fish per haul.

For cod and haddock, a striking similarity was found in the relative abundance of these species for the areas investigated (Tables 1 and 2).

On the whole, the proportion of cod and haddock in the catches was low in all the areas investigated. However, a noticeable increase of these species was found in Area II as compared with adjacent areas.

Haddock was found at 100-200 m in temperatures of 3° - 8°C. Cod preferred lower temperatures (2° - 6°C) and was found at 50-200 m.

Red hake, a heat-loving species, was practically absent on the Scotian Shelf and only occurred occasionally in the catches in the western part.

One of the basic components of the ichthyfauna in the deep parts of the Scotian Shelf is the redfish. It also makes up a considerable part of the total catch (Tables 1 and 2). Redfish concentrations were observed at 110-210 m in temperatures of 5° - 8°C. In area III redfish was caught by trawl in the Gulf of Maine in concentrations at 150-200 m and 3° - 7°C.

(b) The distribution of pelagic and bathypelagic species.

As mentioned above, reliable data on the distribution and abundance of this group of fishes cannot be obtained using the 27.1 m trawl. However, the great number of stations occupied permits an approximate judgement of the distribution and biomass of these species.

Herring was found at 60-200 m in temperatures ranging from 3° to 11°C. Considerable concentrations were observed in the deep parts of the Scotian Shelf (4X). Herring made up a significant proportion of the total yield from Areas I and III because of its high catches. As in many other cases, Browns Bank was characterized by peculiarities in relation to herring fishing (Tables 1, 2) since the proportion of herring in the catches was considerably less than in the neighbouring areas.

Argentine occurred on the slopes of the western part of the Scotian Shelf mainly (4X) where it made up a rather important portion of the total catch. The concentrations of argentine were found at 180–215 m in 4° - 6°C.

Spiny dogfish was entirely absent in Area I, was occasionally caught in Area II and contributed a considerable share of the total catch from the western part of Area III where it occurred at depths of 35-80 m in temperatures of 9° - 12°C.

Butterfish was caught in the area of Nantucket Shoals and in the southern part of Georges Bank.

Among the fishes grouped under the title "other fishes", herring of the genus *Alosa* predominated by weight and number.

Squid, *Illex illecebrosus*, was generally found in Areas I and II along the slopes of the Shelf. Concentrations were found in deep waters at 6° - 10°C. On Georges Bank abundance decreased sharply and *Loligo pealii* began to occur in the catches.

(c) The assessment of pure stock.

The choice of catchability coefficients for assessment of biomass of flatfishes, rays and silver hake was described in the section "Materials and Methods". It was assumed that, during the summer survey (July-August), the behaviour of these species on the Scotian Shelf and in the area of Georges Bank was, in general, analogous to the behaviour of the same species during the US groundfish surveys on the shelf and on Georges Bank.

The element of subjectivity in the coefficients obtained was, of course, rather significant. Thus, too much importance cannot be attached to the assessments of pure stocks (Table 3).

These assessments should be considered tentatively showing the opportunities for the fishery of one or another species. The importance of the data received in this way will increase to a great extent if similar surveys are carried out annually. This provides a chance to compare the fluctuations of the stock of the various species.

Table 3. The assessment of pure stocks of some species in the areas of the Scotian Shelf and Georges Bank (in tons)

Species	Areas I	II	III	Total
Plaice	78,829	1,407	10,285	90,521
Yellowtail flounder	22,430	178	11,148	33,756
Rays	39,751	7,895	40,219	87,865
Silver hake	51,315	36,483	245,327	333,125
Total:	192,325	45,963	306,969	545,257

The data appear to support previously mentioned opinions on the peculiarities of the environmental conditions in Area II. Plaice, a cool-water-loving species appeared to be the most numerous in Area I. The biomass of yellowtail flounder in this area was also high. According to US data (Edwards, 1968) another centre of abundance of this species is in the southern part of New England. Judging from the results of the 1963-65 survey mean biomass of yellowtail flounder was about 76,000 tons. The stock of rays in Areas I and III was approximately the same. As expected, the biomass of silver hake appeared to be highest in Area III. However, the stocks turned out to be extremely high, especially in Area III; they didn't agree with the results of the fishery. Perhaps there is some mistake in our calculation of the coefficients of catchability and availability. The coefficient of catchability for silver hake in the areas of commercial concentrations is considered to be higher than 0.2.

The data on stock sizes, summarized by areas investigated, suggest it is possible to catch 20,000-25,000 tons of flatfishes (plaice and yellowtail flounder combined) from these areas annually. Similar recommendations cannot be made for silver hake based on the results of our survey.

Conclusions

1. Results of a trawl survey on the Scotian Shelf and Georges Bank carried out during the cruise of the research vessel *Blesk* in July-August 1968 provide information on distribution and abundance of the bottom and near-bottom species of fish in the areas mentioned. The data on pelagic species are less reliable.

2. A considerable number of young silver hake of the 1967 year-class found in Area I (ICNAF Div.4W) suggests the appearance of a strong year-class in this area.

3. The data on the distribution and abundance of many species in the areas investigated suggest that Browns Bank (ICNAF Div.4X) is unique.

4. The assessments of pure stocks of flatfishes, rays and silver hake are rather approximate and only give a general idea of the prospects for fishing these species. However, surveys similar to those detailed in this paper, if carried out annually, would greatly increase the reliability of the data.

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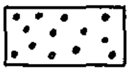
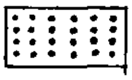
Bigelow, H.B. and W.C. Schroeder, 1953. Fishes of the Gulf of Maine. *Bull. Fish. and Wild Serv.* 53:60-74.

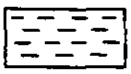
Edwards R.L. 1968. Fishery Resources of the North Atlantic Area. The Future of the Fishing Industry of the United States. *Univ. of Washington Publication in Fisheries. New Series,* Vol.4 1968;52-60.

Konstantinov K.G. and A.S. Noskov, 1966. Soviet Research Report, 1965. *Int. Comm. Northw. Atlant. Fish., Redbook* 1966. II;86-105.

Legend for Figs.1-13

 - haul with catches less than 1 kg.

 - 1 - 10 kg.

 - 11 - 50 kg.

 - 51 - 100 kg.

 - 101 - 200 kg.

 - > 200 kg.

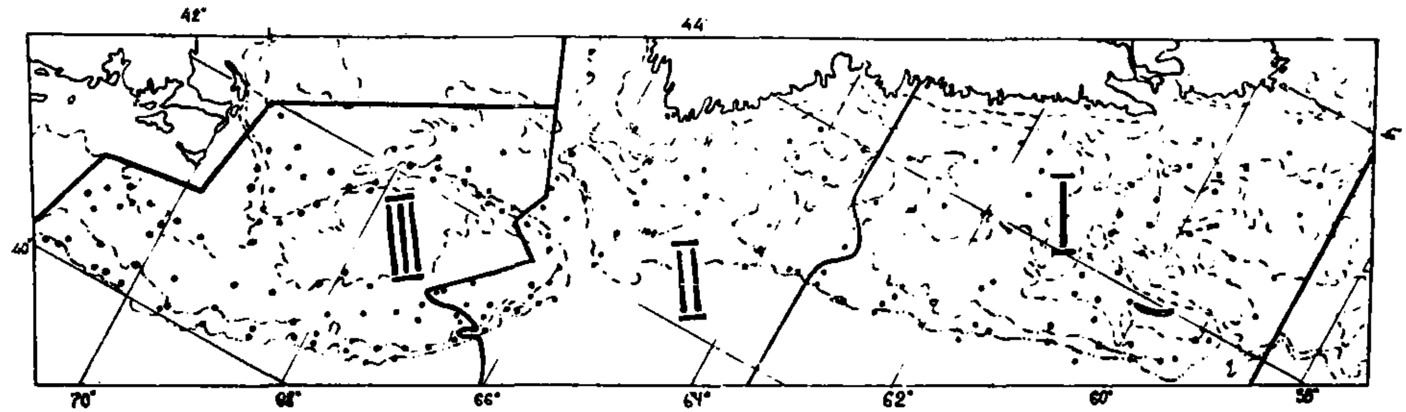


Fig. 1. Chart showing areas of surveys and location of trawling stations.

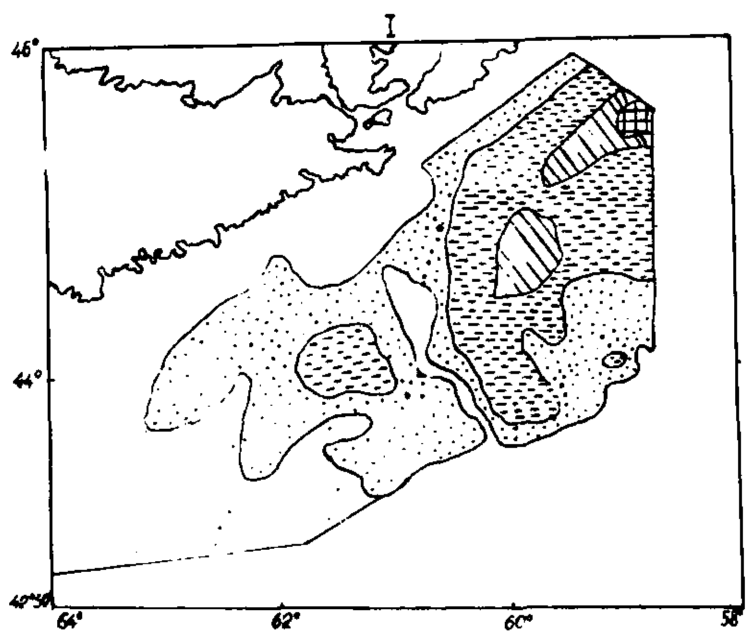


Fig. 2. Distribution of plaice, *Hippoglossoides platessoides*, in Area I.

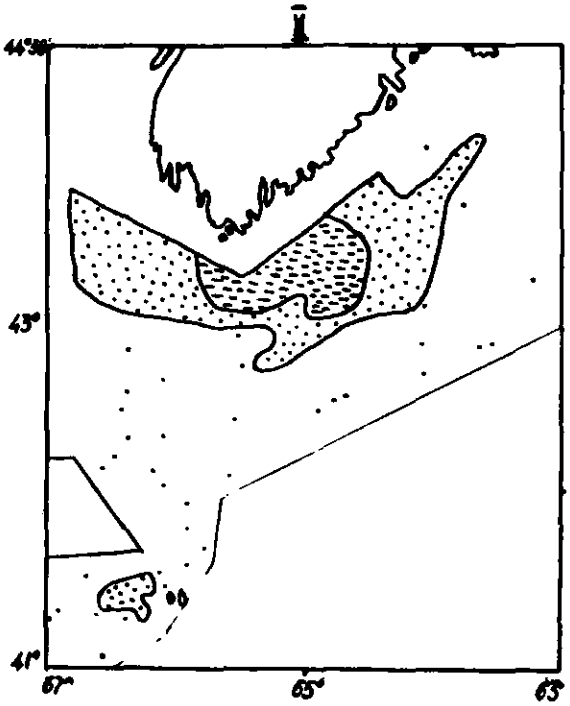


Fig. 3. Distribution of plaice in Area II.

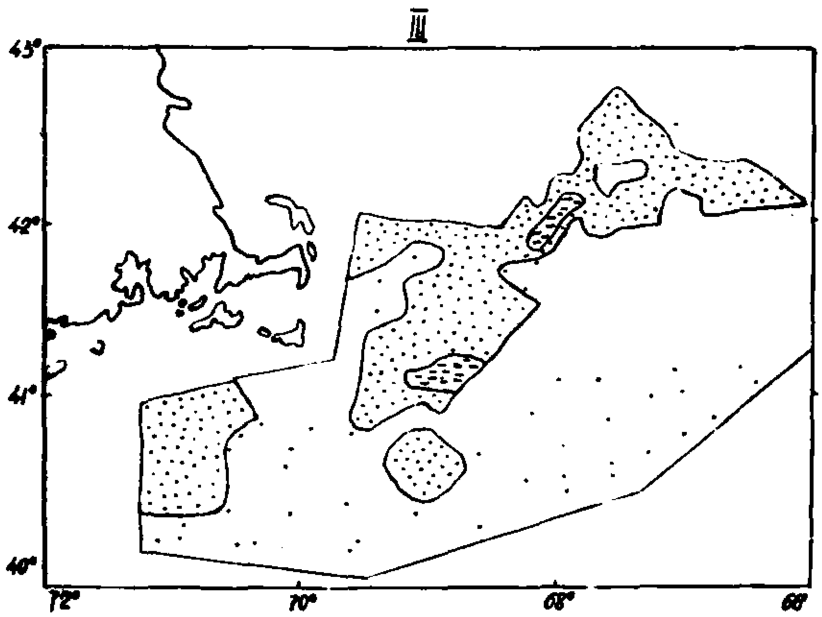


Fig. 4. Distribution of plaice in Area III.

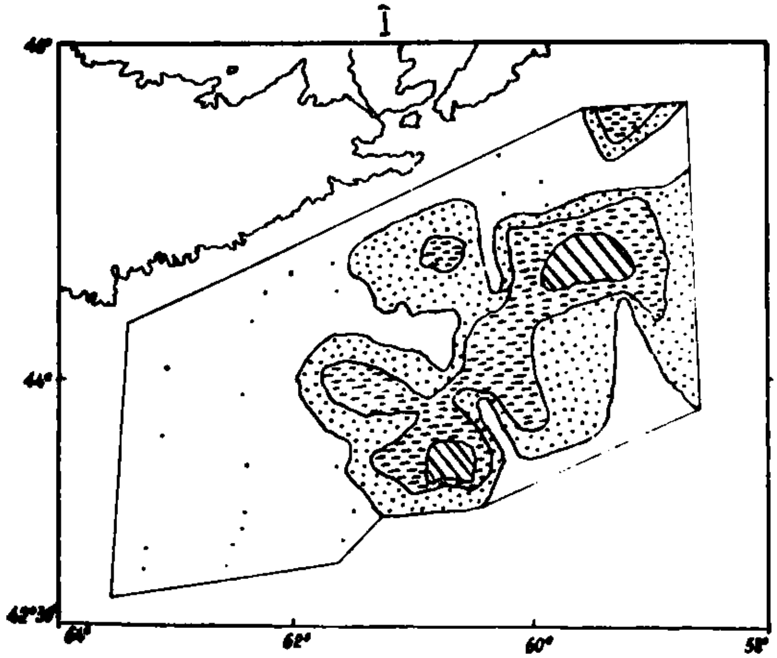


Fig. 5. Distribution of yellowtail flounder in Area I.

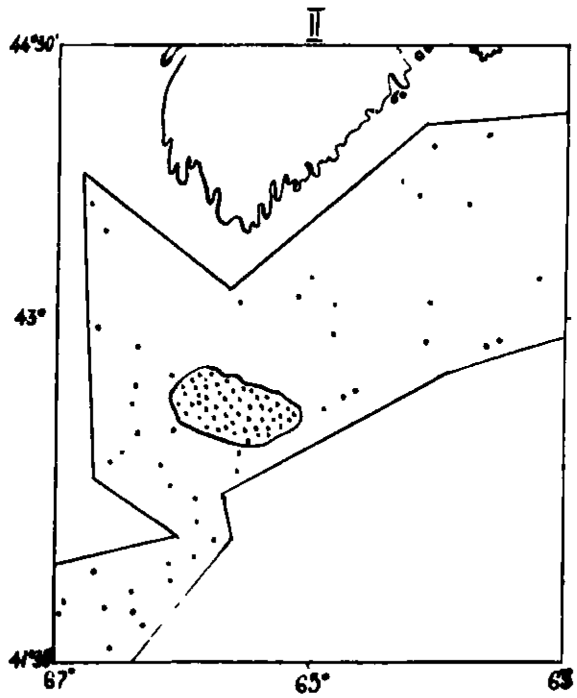


Fig. 6. Distribution of yellowtail flounder in Area II.

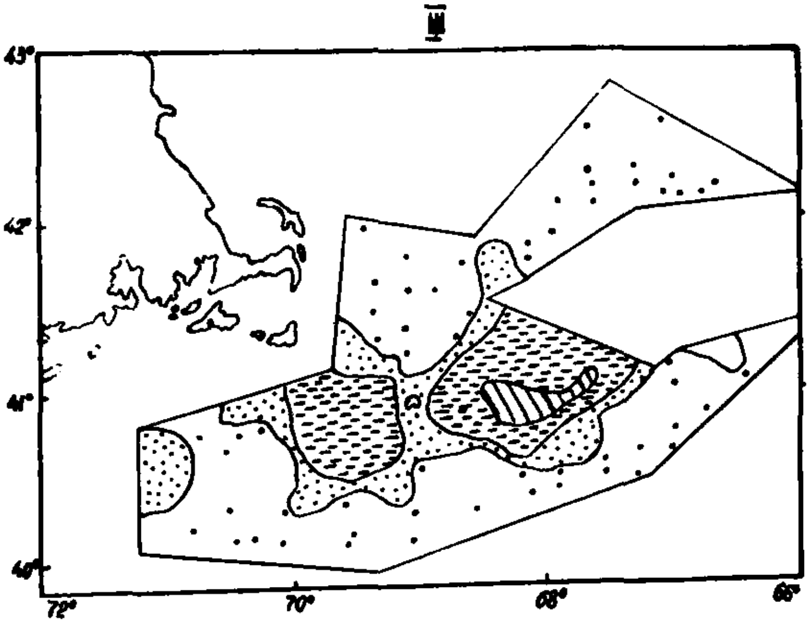


Fig. 7. Distribution of yellowtail flounder in Area III.

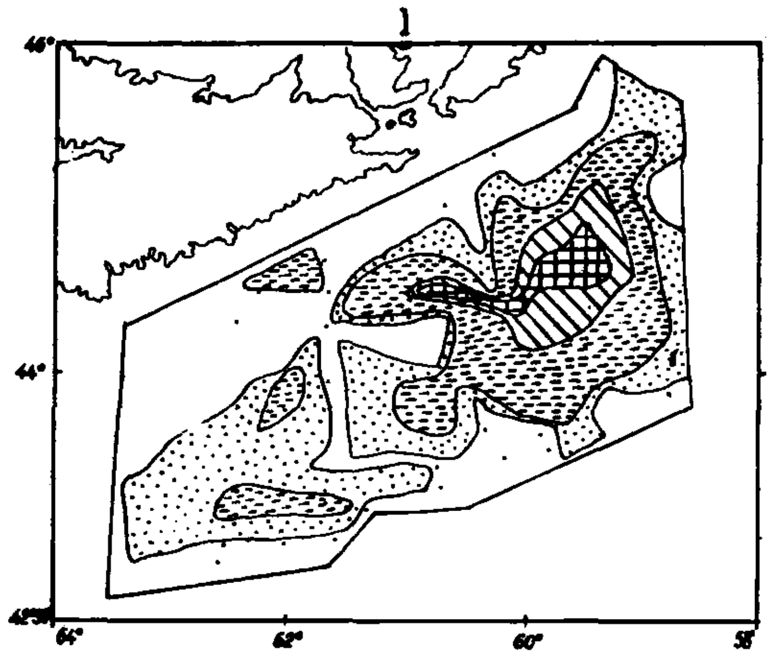


Fig. 8. Distribution of rays in Area I.

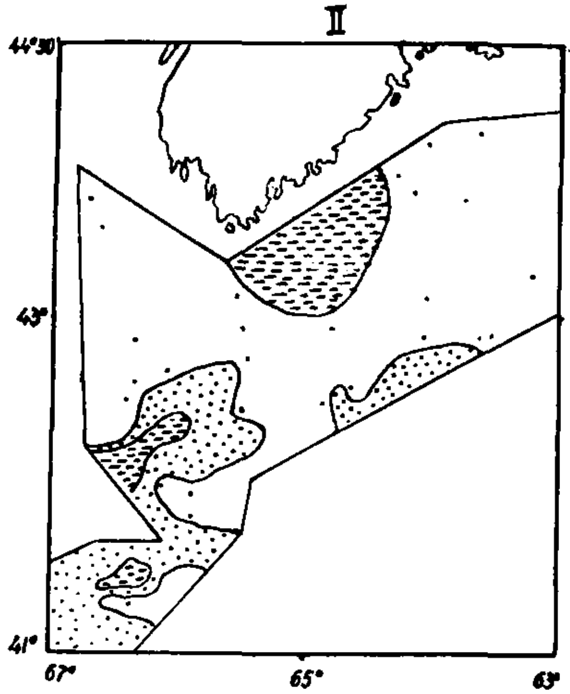


Fig. 9. Distribution of rays in Area II.

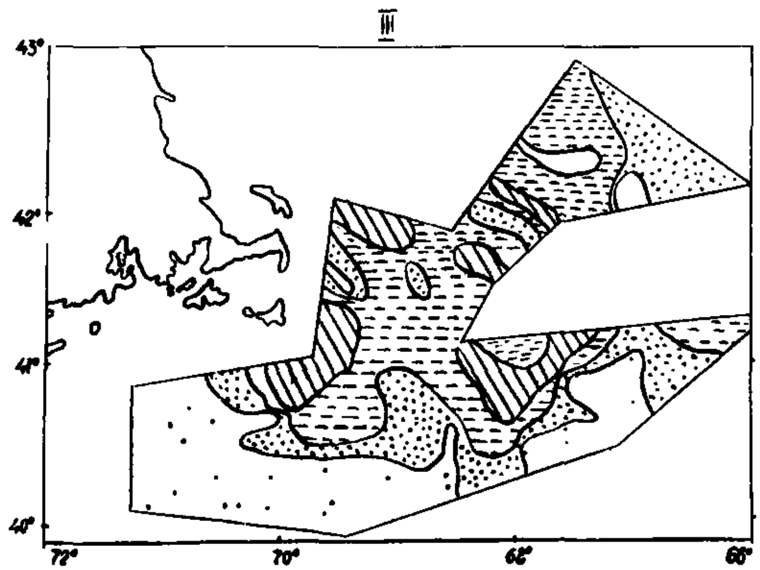


Fig. 10. Distribution of rays in Area III.

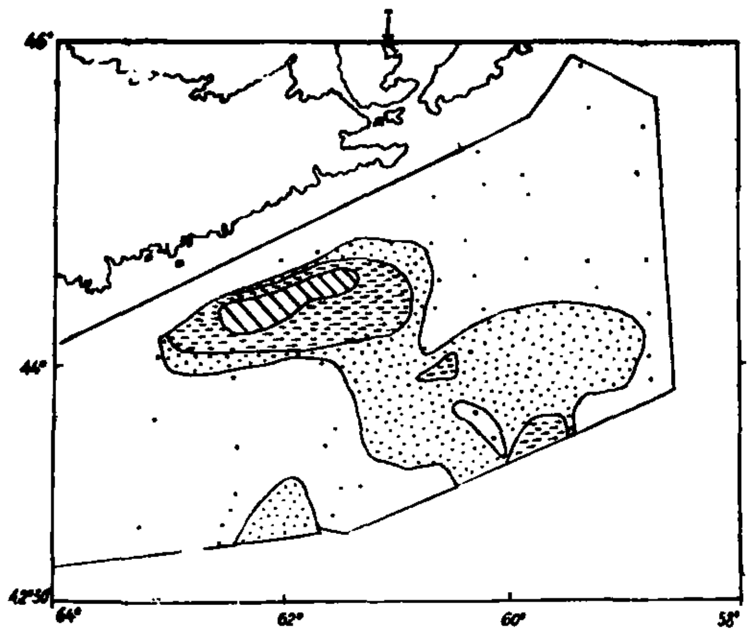


Fig. 11. Distribution of silver hake in Area I.

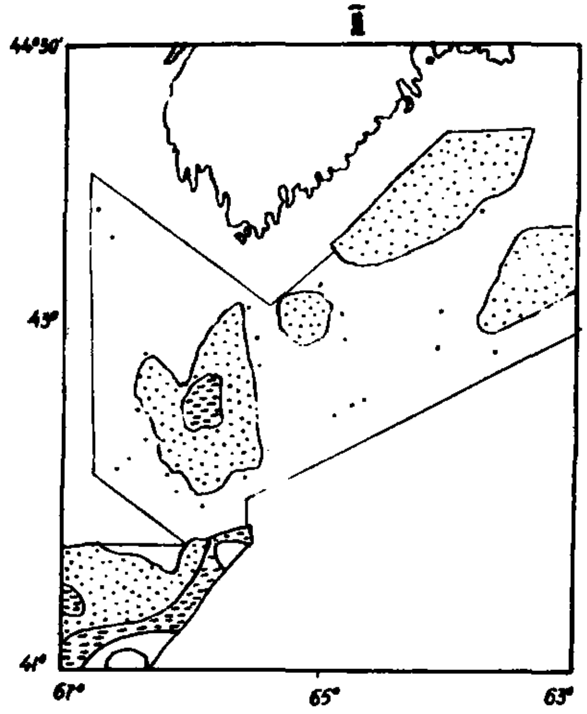


Fig. 12. Distribution of silver hake in Area II.

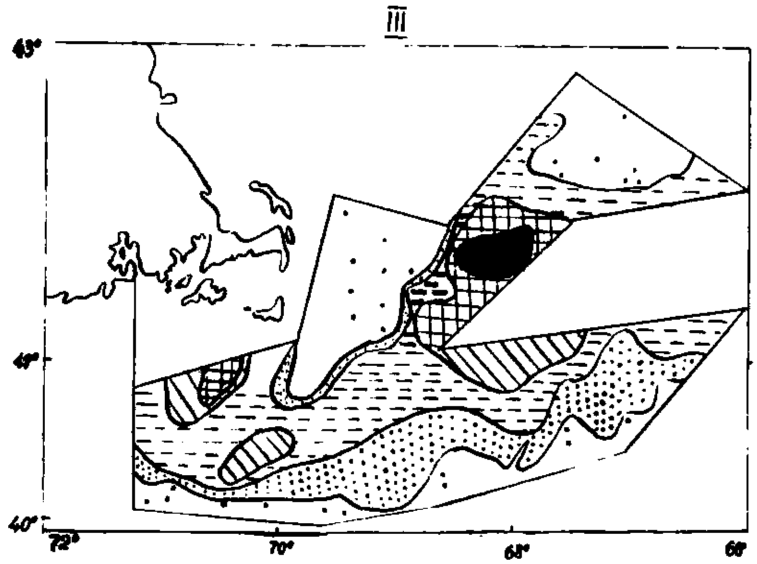


Fig. 13. Distribution of silver hake in Area III.

19. USA-USSR Otter Trawl Survey, Fall 1968[1]

by F.E. Lux,[2] V.A. Richter,[3] and M.D. Grosslein[2]

Introduction

The joint otter trawl survey in 1968 was a continuation and expansion of the series begun in 1967 to monitor distribution and abundance of trawl-caught fish and to study factors affecting trawl efficiency. The area covered in 1968 included fishing grounds between the 30 m and 300 m isobaths from Georges Bank to Cape Hatteras (Fig.1)[4].

Operations were conducted aboard the USSR fish scouting vessel *Blesk*, a side trawler (SRTM) with an overall length of 54.2 m, and aboard the USA fishery research vessel *Albatross IV*, a stern trawler with an overall length of 57 m. The survey covered the period 10 October-7 November 1968.

In this document we summarize catch per haul of selected species and species groups and compare catches of the two vessels used in the 1968 joint survey. Also preliminary comparisons are made between results of the 1967 and 1968 surveys, with respect to abundance and distribution of principal species as well as estimates of relative fishing power of USA and USSR gear. A more complete analysis of these joint surveys is planned for 1970, and probably will include results of a third survey in 1969. It is hoped that these joint surveys will provide both a basis and a stimulus for the development of a program of annual synoptic surveys in ICNAF waters.

Materials and Methods

Detail of gear and methods are given by Grosslein, 1968; the following description therefore is brief.

A stratified random sample design was used (Fig.1). Stratum boundaries were the same in 1967 and 1968; however, the 1967 joint survey covered only strata west and south of 70°W. A sample of the possible stations within each stratum was pre-selected using a table of random numbers, and independent selections were made for each stratum and vessel. A 30-minute otter trawl haul was made at each selected station.

1/ submitted to the 1969 Annual Meeting of ICNAF as ICNAF Res.Doc.69/75.

2/ Bureau of Commercial Fisheries, Woods Hole, Mass., USA

3/ AtlantNIRO, Kaliningrad, USSR

4/ The 1968 joint survey continued north of Georges Bank, to southern Nova Scotia, but on a modified sampling scheme for *Blesk*; that part of the survey is not discussed here.

Blesk used a 27.1 herring trawl with a 27.2 m headrope and 27.4 m footrope. Five footrope rollers (diameter = about 50 cm) were used at a few of the stations on Georges Bank; otherwise, the trawl was used without rollers. *Albatross IV* used a No.36 groundfish trawl with a 20.6 m headrope and a 24.4 m footrope. A set of 19 rollers (diameter = 41 cm) was used on the centre 10.7 m section of the footrope for all hauls. The *Blesk* trawl had a codend of 32 mm mesh twine; the *Albatross IV* trawl was lined in the codend and top belly with 13 mm mesh twine. Both nets therefore retained most sizes of fish caught. In 1967, the *Albatross IV* net was fitted with 18 m ground cables; in 1968 no ground cables were used. Also, in 1967 the headrope of the *Albatross IV* net was 2.4 m longer than in 1968. Towing speed for both vessels was 3.5 k.

Albatross IV, slightly faster than *Blesk* and using a smaller net, was assigned 193 stations in the sampling area; *Blesk* was assigned 146 stations (Fig.2). Cruise tracks were laid out so that both vessels would fish the same stratum within the same 48-hour period.

Bathythermograms were obtained at each station and at selected points along the tracks between stations. These provided coincident estimates of the surface to bottom temperature regime in the survey area.

For each haul the total weight and length frequency of the catch (or representative sample therefrom) were recorded, along with position, depth, and other pertinent information, on trawl logs. When catches were sampled, weight and volume (or number) of sample was recorded as well as volume (or number) of the discarded portion of the catch, to permit computation of total weight and length frequency. Close cooperation and communication between scientific groups on the two vessels and partial exchange of personnel insured uniform processing techniques.

Following the survey, the catch data for both vessels were put through the routine groundfish survey data processing system used at Woods Hole which involves careful hand checking and coding of each trawl log, transfer of data to punched cards, and a series of computer audit runs to eliminate any major errors.

Results

I. Distribution of principal species

There were 105 species of fish and 5 species of invertebrates, for which data were recorded, in catches in the survey area. A relatively small number contributed significantly to the biomass of bottom-trawl catches, however, and it is these to which the discussion here is largely confined.

Catches, by stratum set, in pounds and percentage weight per haul for selected species and in pounds per haul for species groups are given in Tables 1 and 2 and Fig. 3.[5/] In the southern part of the area surveyed (strata 61-76 and 1-12) spiny dogfish, silver hake, sea robin, and squid made up much of the catch. This southern part is approximately the same area as was covered in the 1967 survey. Catches of dogfish and skate in 1968 were lower than in 1967 while groundfish, pelagics, and flatfish were taken in about the same amounts in the two years (Table 2 and Grosslein, 1968). Generally the percentage contribution of the various species was similar in the two years.

In the northern part of the area, which was largely on Georges Bank (strata 13-25), the catch was more evenly divided among the different species rather than being dominated by a few species (Tables 1, 2; Fig.3). Groundfish, flatfish, and skates were the principal groups caught.

The north-south distribution pattern shown in catches presumably is related to temperature, since the water in the southern part of the area generally is warmer than to the north (Fig. 4). The bottom temperature pattern in 1968 differed little from that prevailing during the trawl survey of October 1967 (Grosslein, 1968); however, the temperature was slightly higher in 1968. This effected no marked change in the distribution of principal species, although spiny dogfish were concentrated farther north in 1968 than in 1967.

II. Fishing Power Comparisons

In the 1968 survey, *Blesk* with fairly high consistency made bigger total catches than *Albatross IV* (Tables 1-2). We attribute this largely to the greater mouth area of the *Blesk* trawl, but differences in trawl design and rigging relative to fish behaviour undoubtedly were involved also.[6/] In 1968 as in 1967 the advantage of the larger trawl appeared not to be the same for all kinds of fish; in particular the relative catch difference was rather consistently less for flatfish as a group than for other species groups (Table 2). Pelagic fish show the greatest variation in catch ratios, which is not surprising in view of the high schooling tendencies of this group (Table 2).

5/ Composition of species groups. Dogfish: all dogfish species, skate: all skates and the torpedo; groundfish: cod, haddock, cusk, and all hakes; pelagic: mackerel, butterfish, scup, and all herrings; flatfish: halibut and all flounders.

6/ Acoustical measurements in 1968 of the trawls under tow indicated that the wing-spread of the *Blesk* trawl was 1.25 times, and headrope height two times that of the *Albatross IV* trawl, for a total mouth area of approximately twice that of the *Albatross IV* net. Catch differences in relation to trawl configuration have not yet been fully analyzed.

Table 1. Stratified mean catch in pounds per 3- minute haul for selected species and for all species combined in fall 1968, by stratum set and vessel (USA - *Albatross IV*; USSR - *Blesk*).

Species	Stratum Set																			
	61-68		69-72		73-76		1-4		5-8		9-12		13-15		16-18		19-20		21-25	
	USA	USSR	USA	USSR	USA	USSR	USA	USSR	USA	USSR	USA	USSR	USA	USSR	USA	USSR	USA	USSR	USA	USSR
Smooth dogfish	4	13	19	5	4	56	1	-	1	2	1	1	-	-	-	-	-	-	-	-
Spiny dogfish	-	-	1	29	23	9	152	1360	172	395	64	270	2	27	-	-	19	13	24	8
Little skate	-	-	-	-	-	3	-	4	-	1	4	13	9	25	3	7	10	24	6	2
Silver hake	1	4	1	3	5	37	6	96	19	175	8	33	5	11	3	11	4	26	7	12
Cod	-	-	-	-	-	-	2	-	2	13	1	4	-	-	3	18	12	17	26	19
Haddock	-	-	-	-	-	-	-	-	-	-	-	-	-	-	19	5	8	1	45	29
Red hake	-	-	1	1	5	7	5	16	22	46	2	5	6	20	3	6	1	1	1	14
Spotted hake	11	13	2	2	4	4	-	1	-	-	-	1	-	-	-	-	-	-	-	-
Yellowtail fldr.	-	-	1	-	42	36	35	52	25	5	13	20	15	22	20	1	21	28	6	1
Winter fldr.	-	-	1	-	9	4	2	2	3	23	2	-	-	-	-	2	6	8	7	1
Scup	4	13	-	-	-	-	-	-	2	1	1	8	-	-	-	-	-	-	-	-
Sea robin	32	139	45	39	12	-	-	-	-	-	1	2	-	-	-	-	-	-	-	-
Goosefish	-	-	1	-	3	6	1	13	4	15	2	3	1	-	6	-	-	-	8	3
Lobster	1	-	2	1	3	2	4	3	3	5	4	4	6	1	3	1	3	2	1	-
Sea scallop	-	-	-	-	3	1	5	2	-	-	-	-	-	-	-	-	-	-	-	-
Squid (<u>Loligo</u>)	21	39	26	18	13	14	33	8	30	26	18	41	2	8	2	-	-	2	1	-
Total (all species)	134	302	222	117	163	188	265	1578	336	904	139	435	68	141	92	101	139	164	234	270
No. of hauls	28	22	18	14	16	13	22	17	19	15	21	14	16	12	15	11	15	10	23	18

Table 2. Stratified mean catch in pounds per 30 minute haul for selected species groups and all species combined in fall 1968, by stratum set and vessel (USA - *Albatross IV*; USSR - *Blesk*).

Stratum set	Vessel	Species group: Dogfish	Skate	Groundfish	Pelagic	Flatfish	All species
61-68	USA	4.1	0.2	11.7	9.9	3.5	133.8
	USSR	12.3	2.7	16.9	42.5	2.7	302.0
	USA/USSR	0.33	0.07	0.69	0.23	1.30	0.44
69-72	USA	20.4	---	3.7	106.1	10.8	221.6
	USSR	34.3	2.6	5.5	2.8	2.4	116.7
	USA/USSR	0.59	---	0.67	37.89	4.50	1.90
73-76	USA	26.7	1.5	13.5	21.4	63.1	163.3
	USSR	65.8	3.5	48.1	0.9	40.7	187.6
	USA/USSR	0.41	0.42	0.28	23.77	1.55	0.87
1-4	USA	153.2	0.6	15.1	8.6	39.3	284.9
	USSR	1,359.6	4.0	113.5	10.3	55.7	1,677.8
	USA/USSR	0.11	0.15	0.13	0.83	0.70	0.17
5-8	USA	172.6	1.7	52.0	26.2	37.5	335.9
	USSR	396.4	1.0	242.9	175.4	36.4	903.8
	USA/USSR	0.44	1.70	0.21	0.15	1.03	0.37
9-12	USA	64.1	5.8	11.9	6.4	21.6	139.3
	USSR	271.0	13.7	44.5	17.7	28.1	434.7
	USA/USSR	0.24	0.42	0.27	0.36	0.77	0.32
13-15	USA	1.9	17.3	12.1	0.6	19.1	68.0
	USSR	27.4	36.4	31.4	3.9	23.6	141.1
	USA/USSR	0.07	0.48	0.38	0.15	0.81	0.48
16-18	USA	---	18.4	28.6	1.3	21.8	92.3
	USSR	0.2	16.5	41.7	32.7	3.7	101.1
	USA/USSR	---	1.12	0.68	0.04	5.89	0.91
19-20	USA	18.7	34.8	27.3	10.4	29.1	138.8
	USSR	13.2	37.5	46.3	14.6	42.2	163.8
	USA/USSR	1.42	0.93	0.59	0.71	0.69	0.84
21-25	USA	24.1	34.4	95.1	3.4	29.9	234.3
	USSR	7.5	65.0	98.8	4.0	24.6	269.7
	USA/USSR	3.21	0.53	0.96	0.85	1.22	0.87
61-76, 1-12	USA	77.6	1.7	18.4	26.6	28.2	210.5
	USSR	393.5	4.7	81.6	43.7	28.1	633.7
	*USA/USSR	0.20(.37)	0.36(.16)	0.23(.17)	0.61(.59)	1.00(.79)	0.33(.56)
13-25	USA	12.5	27.2	45.8	4.0	25.5	143.3
	USSR	11.4	41.2	58.7	13.1	23.8	178.2
	USA/USSR	1.10	0.66	0.78	0.30	1.07	0.80
All strata	USA	54.6	10.7	28.1	18.6	28.2	186.7
	USSR	288.1	17.6	73.5	32.8	26.6	472.2
	USA/USSR	0.21	0.61	0.38	0.57	1.06	0.39

*1967 values in parentheses.

The catch data on log scale offer a more precise measure of relative fishing power of the two vessels (Table 3). In the southern part of the survey (strata 61-76, 1-12) *Blesk* caught more of all species listed, except as expected for yellowtail flounder, than did *Albatross IV* (Table 3). In the Georges Bank area (strata 13-25) the relative fishing power of *Blesk* decreased and this may be related to the change in species composition.

A comparison of 1967 and 1968 fishing power factors for red and silver hake, spiny dogfish and all species combined indicates that all were within limits of sampling error (i.e., relative performance of USA and USSR gear was comparable in the two years for strata 61-76, 1-12).

The ratio of catches per haul of all species of the USA vessel to the USSR vessel in 1967 plotted against the same ratio for 1968 shows catch comparisons for the individual southern stratum sets and for all southern strata combined (Fig. 6). Most of the points fall reasonably close to the diagonal, as would be expected if relative fishing power were about the same in each year. One point, however, (for stratum set 69-72) indicates that *Albatross IV* catches were much larger than those of the USSR vessel in 1968 than in 1967. Detailed catch information for this stratum set shows that large catches there of butterfish by *Albatross IV* in 1968 and small catches of this species by *Blesk* caused this deviation. This illustrates again the difficulty of making quantitative comparisons of fishing power because of large variation in catch data.

The catch data for silver hake and red hake for both 1967 and 1968 show some indication that the relative fishing power of the USSR gear was greater at higher levels of abundance (Fig. 5). Why this should be so is unknown; however, it may be related to the behaviour of schooling fish at various abundance levels. In any case, it brings into question an assumption that a simple multiplicative model relating fishing power of two vessels holds for all species at all levels of abundance.

III. Abundance in 1968 vs. 1967

Since the survey in 1968 covered strata 61-76 and 1-12 (Fig.1) which was very nearly the area covered in fall 1967, a comparison between years is possible for part of the survey (Fig.5). These data, for spiny dogfish, silver hake, red hake, and all species combined, indicate that catches were slightly lower in 1968. This was true for spiny dogfish, in particular, and, in strata 61-72, for silver hake. Abundance of silver hake in strata 73-76, 1-4, and 5-12 was similar in the two years; landings per day by the USA commercial fleet in approximate area represented by strata 5-12 also was similar in these years.

Reference

Grosslein, M.D. 1968. Results of the joint USA-USSR groundfish studies. Part II. Groundfish survey from Cape Hatteras to Cape Cod. *Annu. Meet. int. Comm. Northw. Atlant. Fish.*, Res.Doc.68/87, Ser. No. 2075.

Table 3. Stratified mean catch in pounds (log scale) per 30 minute haul for selected species and for all species combined in 1968, by stratum set and vessel (USA - *Albatross IV*; USSR - *Blesk*).

	Species															
	Spiny dogfish		Silver hake		Red hake		Cod		Haddock		Yellowtail		All species		All species
Stratum set	USA	USSR	USA	USSR	USA	USSR	USA	USSR	USA	USSR	USA	USSR	USA	USSR	USA / USSR
61-68	0.028	0.038	0.202	0.225	0.353	0.082	-----	-----	-----	-----	-----	-----	4.390	5.171	0.46
69-72	0.345	0.406	0.525	0.647	0.343	0.300	-----	-----	-----	-----	0.298	0.092	4.550	4.025	1.70
73-76	2.155	1.688	1.409	2.833	1.065	1.326	-----	-----	-----	-----	2.331	1.592	4.962	5.134	0.84
1-4	2.811	3.829	1.567	3.843	1.102	2.063	0.192	-----	-----	-----	2.427	2.495	5.053	6.015	0.38
5-8	3.681	4.642	2.348	4.320	1.867	2.492	0.336	0.577	0.137	-----	2.200	0.885	5.416	6.293	0.42
9-12	2.629	3.394	1.524	2.809	0.654	1.049	0.217	0.300	-----	-----	1.448	1.698	4.376	5.149	0.46
13-15	0.463	1.876	1.580	1.955	1.466	1.600	-----	-----	-----	-----	1.404	1.512	3.943	4.454	0.60
16-18	-----	0.133	0.936	1.012	0.821	0.815	0.458	1.382	0.816	0.608	1.962	0.537	3.956	4.425	0.63
19-20	2.538	2.150	1.182	2.153	0.221	0.580	1.404	1.572	0.353	1.913	1.815	2.018	4.770	4.942	0.84
21-25	1.850	0.549	1.344	1.426	0.286	0.483	1.910	1.594	2.773	2.692	0.675	0.243	5.306	5.290	1.02
61-76, 1-12															
Mean	1.979	2.428	1.272	2.486	0.842	1.242	0.134	0.153	0.023	0.000	1.449	1.158	4.788	5.360	0.56
Variance	0.014	0.026	0.006	0.017	0.010	0.017	0.003	0.007	0.001	0.000	0.017	0.026	0.008	0.014	
*Fishing power factor: (USA/USSR)	0.64 (.98)		0.30 (.31)		0.67 (.40)		0.83		----		1.34		0.56 (.62)		
13-25															
Mean	1.295	1.121	1.262	1.619	0.645	0.821	1.048	1.201	1.152	1.040	1.400	1.008	4.578	4.724	0.86
Variance	0.023	0.024	0.014	0.031	0.011	0.026	0.032	0.040	0.030	0.028	0.038	0.034	0.012	0.028	
*Fishing power factor: (USA/USSR)	1.20		0.70		0.84		0.86		1.12		1.48		0.86		

*The fishing power factors are the antilogs of the differences between log means, USA-USSR. Corresponding values for 1967 survey shown in parentheses.

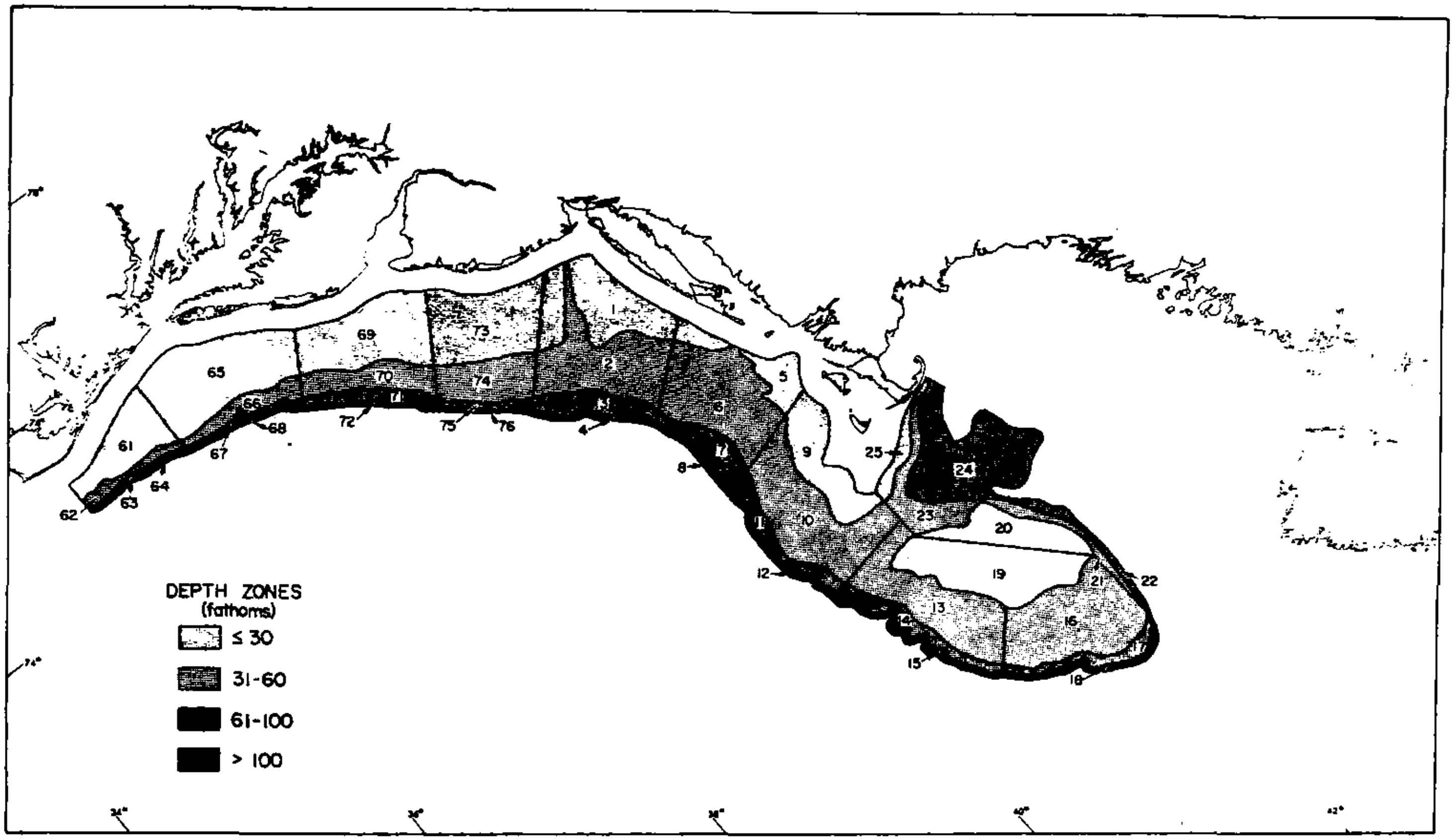


Fig. 1. Sampling strata in the area covered by the USA-USSR otter trawl survey in fall 1968.

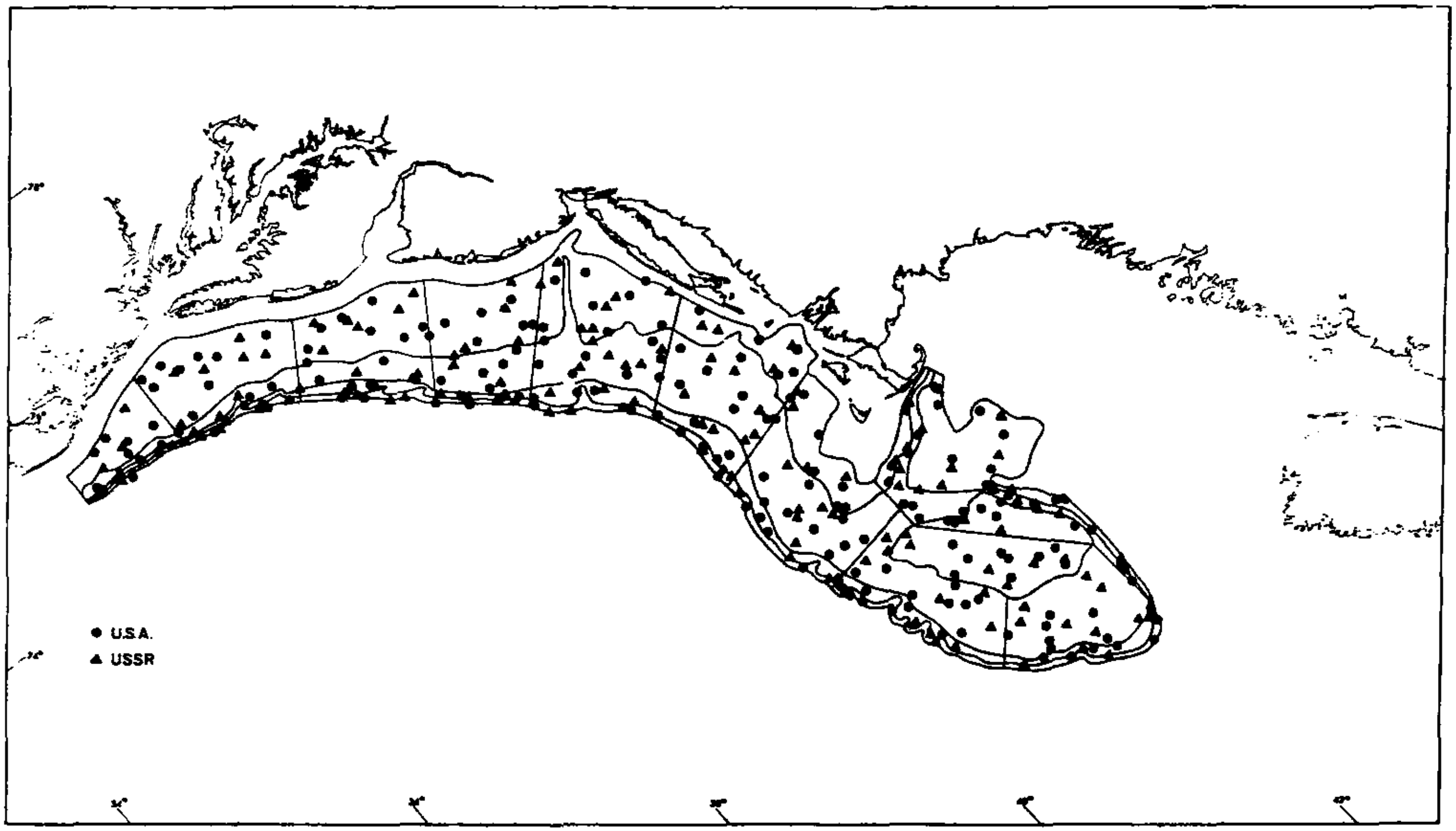


Fig. 2. Otter trawl stations occupied during the USA-USSR survey, fall 1968.

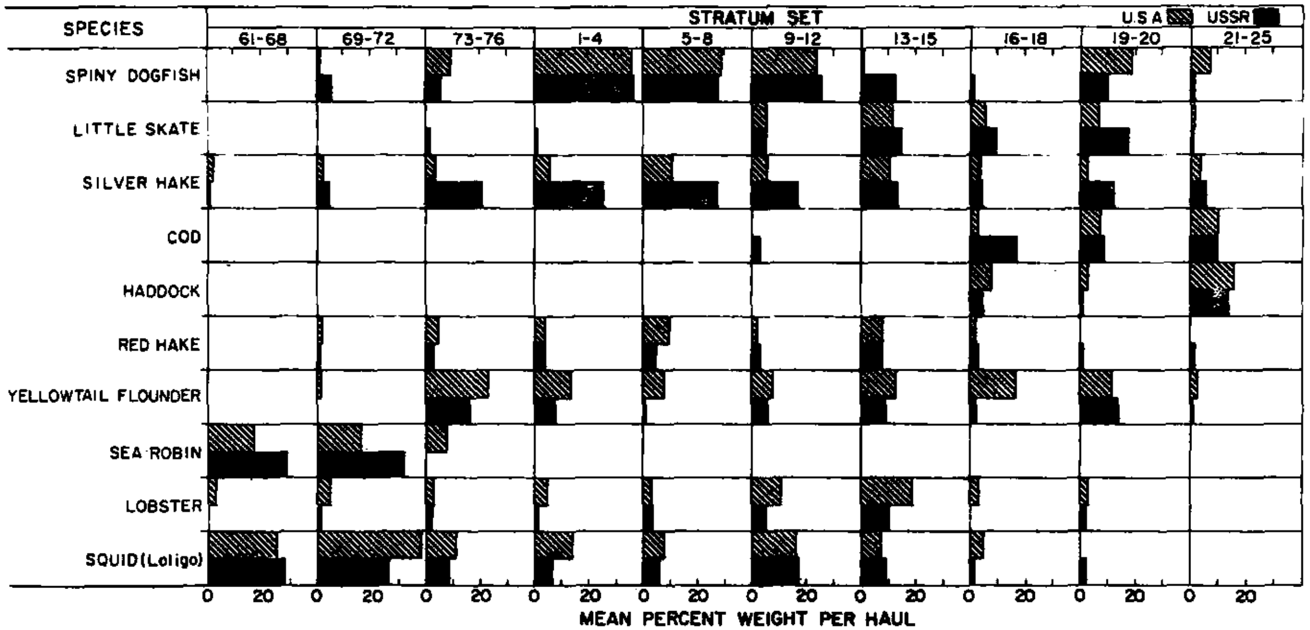


Fig. 3. Stratified mean percentage contribution of weight per haul of selected species in ten stratum sets for the USA and USSR research vessels in the fall survey, 1968.

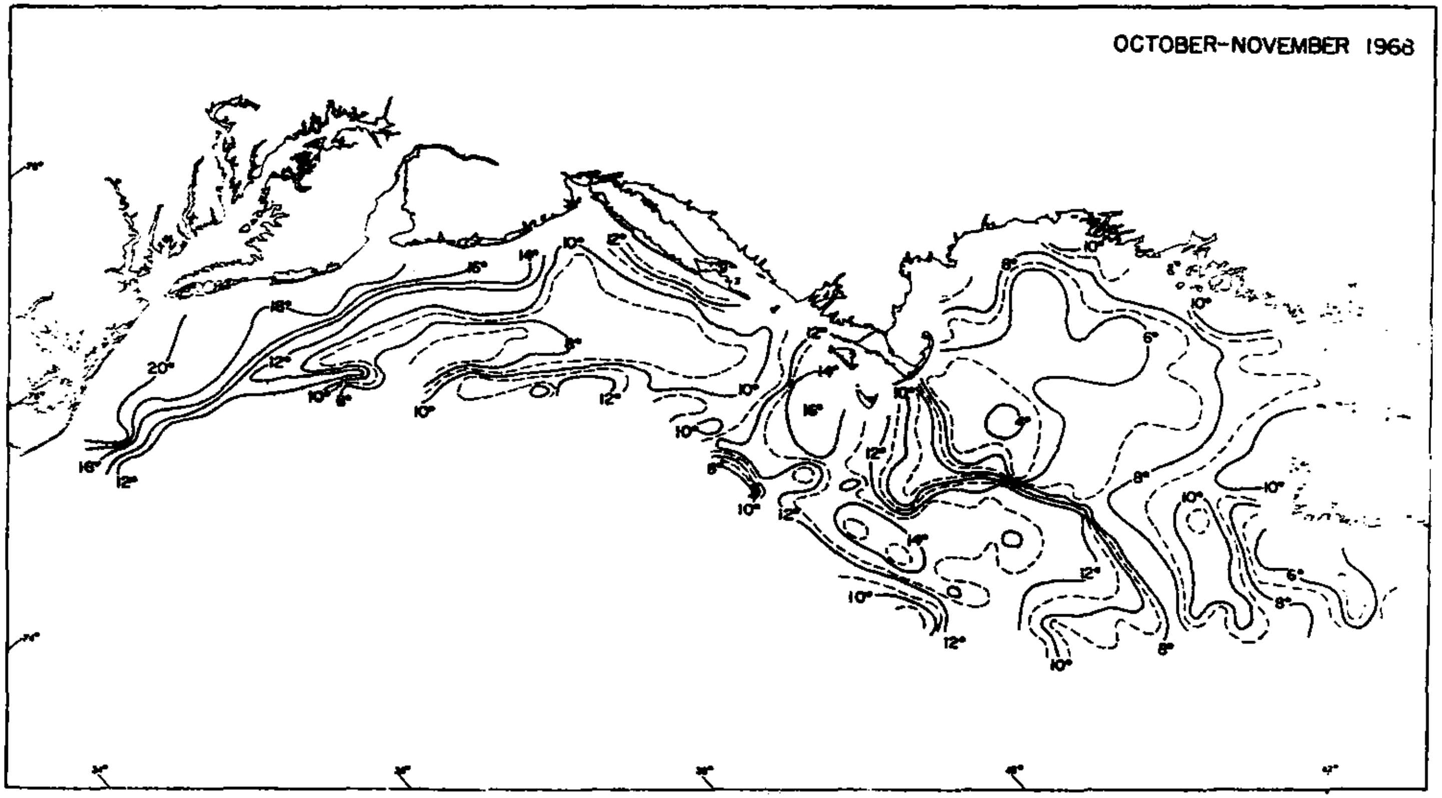


Fig. 4. Bottom temperature ($^{\circ}C$) in fall 1968, based on bathythermograms obtained during the USA-USSR otter trawl survey.

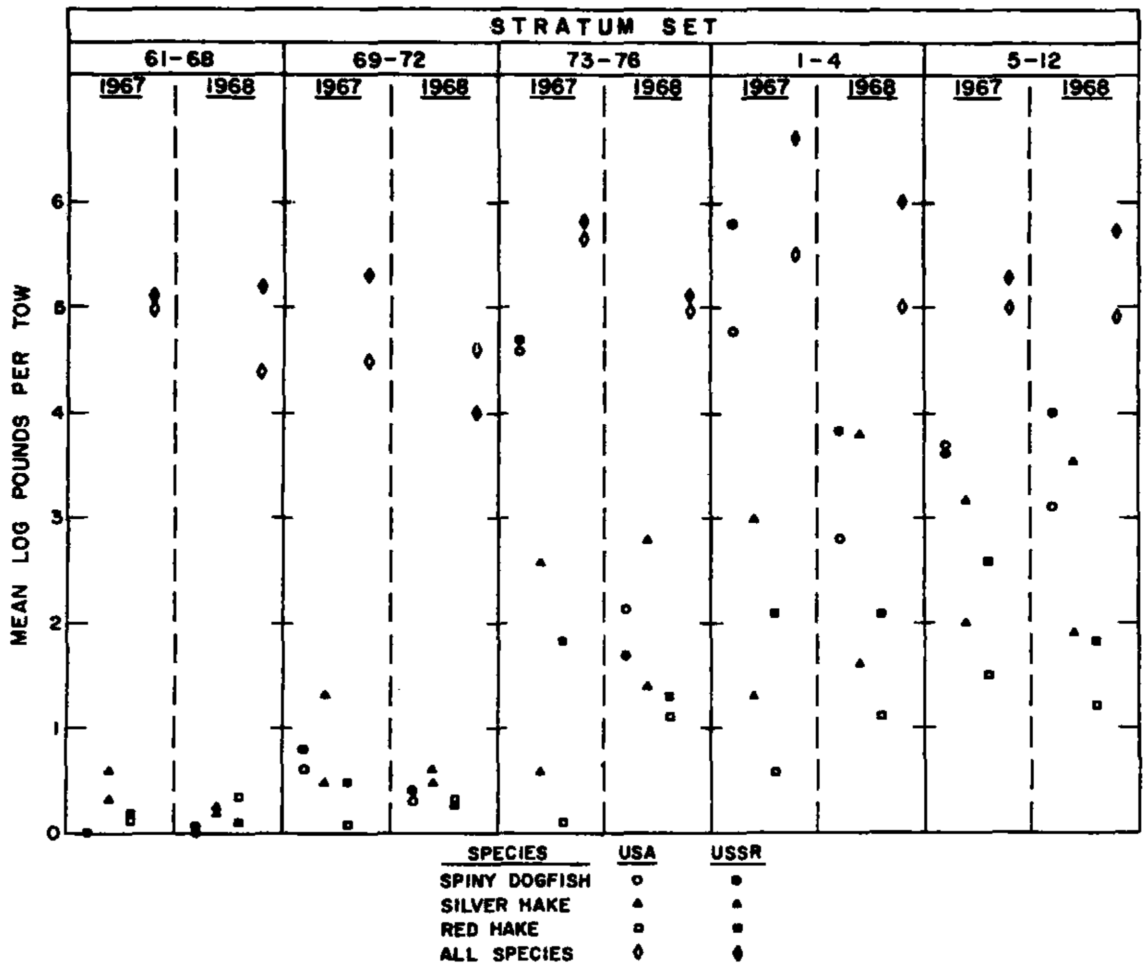


Fig. 5. Stratified mean catch in pounds per haul (log scale) of spiny dogfish, silver hake, red hake, and all species combined for the USA and USSR vessels in 1967 and 1968 in five stratum sets. (In 1967 only the area west of 70°W in strata 9-12 was included in stratum set 5-12. In 1968 all of the area within these four strata was included).

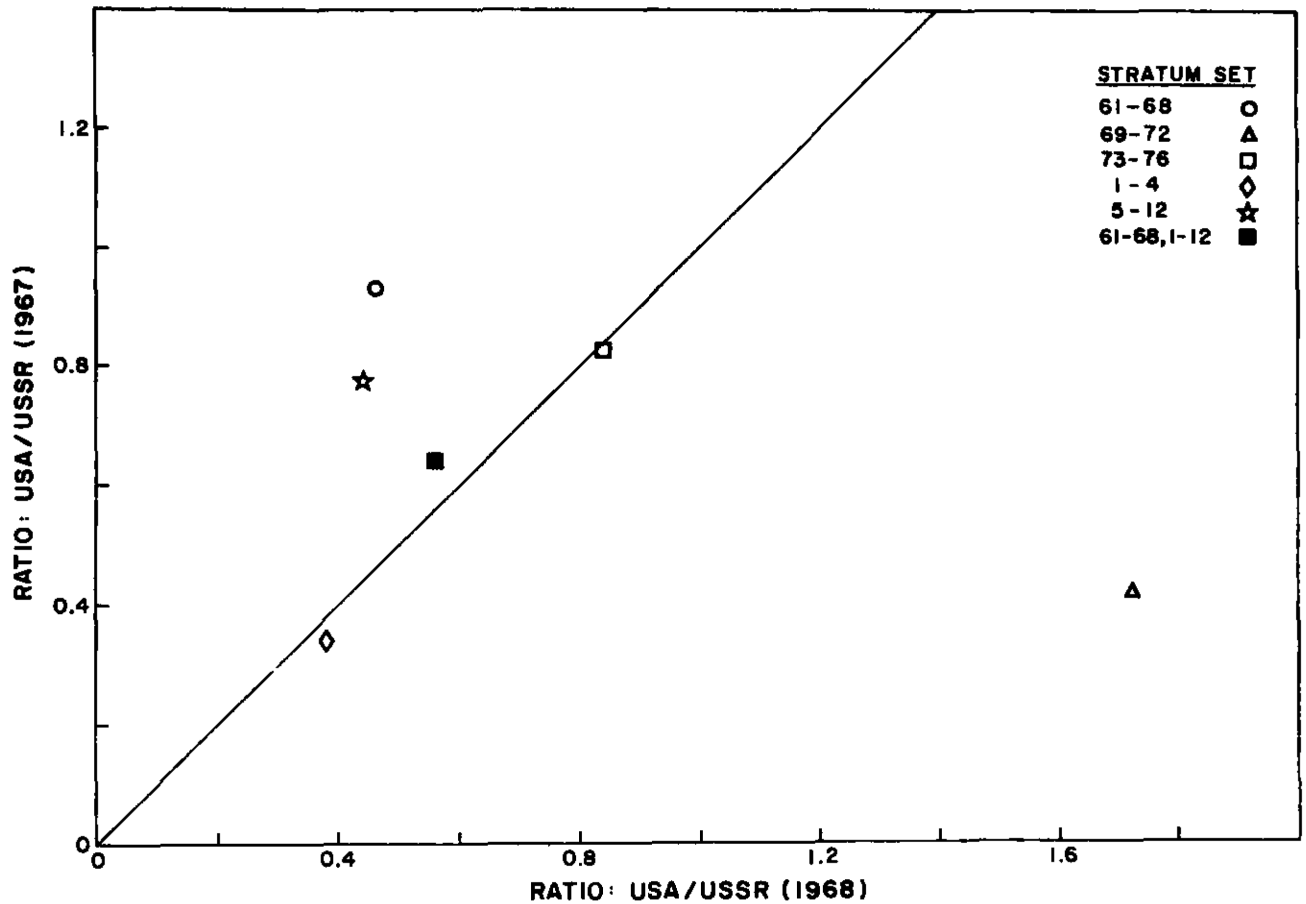


Fig. 6. Ratio of stratified mean catch per haul in pounds (based on difference between stratified means on log scale) of the USA and USSR vessels in 1967 plotted against the same ratios for 1968, in the five southern stratum sets (open symbols) and all southern strata combined (solid square).