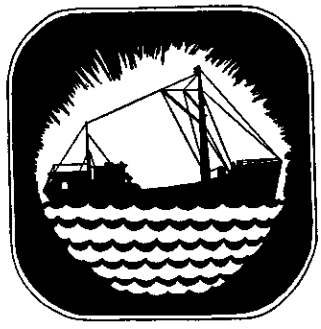
INTERNATIONAL COMMISSION

FOR THE

NORTHWEST ATLANTIC FISHERIES



ANNUAL PROCEEDINGS

VOL. 3

for the year

1952-53

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CONTENTS

Foreword

At the Third Annual Meeting, May 1953, the Commission decided to establish its publications in two annual series, a "Statistical Bulletin" and an "Annual Proceedings".

The Statistical Bulletin will deal with the fisheries statistics of the Convention Area, mainly those for the year in question, but also with statistics for former years collected and compiled by the Commission.

The Annual Proceedings will contain the Commission's reports for the year in question: the Administrative Report, the Report of the Annual Meeting. Summaries of Research by participating countries, certain Scientific Papers especially prepared for the Annual Meeting, and an Annotated List of Papers of special interest to the Commission's work.

Occasional Papers from the Commission may be published separately.

The present Annual Proceedings is numbered Vol. 3. The "Report of the First Annual Meeting", Washington D.C., 1951 and the "Second Annual Report for the year 1951-52", St. Andrews, N. B., 1952 being considered as Vol. 1 and Vol. 2.

The Annotated List of Papers will appear from the next year's Annual Proceedings.

The Statistical Bulletin for the year 1952 will be published towards the end of the year.

Erik M. Poulsen,
Executive Secretary

PART 1

Administrative Report for the Year ending 30 June 1953

by the Executive Secretary, Erik M. Poulsen

1. Headquarters.

Temporary headquarters of the Commission has been at the Atlantic Biological Station of the Fisheries Research Board of Canada, St. Andrews, New Brunswick, Canada. Until 1 December 1952 the Commission occupied three smaller rooms in the groundfish building. By the beginning of December, however, our offices were moved to a larger building where four spacious and comfortable rooms were made available to the Secretariat.

This change of headquarters offices caused a great improvement in working conditions and is greatly appreciated by the Secretariat, and so is the valuable assistance and great help in many ways given by the Atlantic Biological Station through the whole of the year.

Following the resolution of the Second Annual Meeting that the selection of future headquarters should be postponed until the next annual meeting and that, in the meantime, the possibility of sites other than St. John's and Halifax should be explored by a committee consisting of the Chairman and a representative from Iceland (Mr. P. Eggerz) and from Spain (Mr. G. Baraibar, since March replaced by Mr. V. Trelles) with the Executive Secretary as adviser, a great effort has been made in such an exploration.

In the course of the year new offers were received from various places in Canada and U.S.A. to the effect that by March 1953 offers were at hand from the following places:

In Canada: St. John's, Newfoundland; Halifax, Nova Scotia; Montreal, and Quebec.

In U.S.A.: Kingston, Rhode Island; Boston (Harvard) Massachusetts; Gloucester, Massachusetts; Durham, New Hampshire; Brunswick Maine; New Bedford, Masschusetts.

The Executive Secretary submitted to the Committee a report including a description of the various offers and his appraisal of them. This report was considered by the Committee and dealt with at a committee meeting in Montreal on the 17th of March.

2. Secretariat.

At the Second Annual Meeting in June-July 1952 Dr. Erik M. Poulsen, Copenhagen, Denmark, was appointed Executive Secretary. He took over his position with the Commission on 10 October 1952. Dr. W. R. Martin continued as Acting Executive Secretary until the end of November 1952. This overlapping was highly advantageous as it secured a certain continuity of staff work and made it possible for the new executive secretary to draw lavishly from Dr. Martin's great experience in and thorough knowledge of Commission matters.

Following a resolution of the Second Annual Meeting that the staff be increased to include an additional clerk-stenographer, Miss Theresa H. Devine (Ottawa, Canada) was appointed clerk-stenographer with the Commission and took up this post on 1 February 1953.

3. Officers.

At the Second Annual Meeting Dr. J. L. Kask (U.S.A.) was elected Commission Chairman for the ensuing year. Mr. A. T. A. Dobson (U. K.), who had acted as Chairman since Mr. Hilary J. Deason (U.S.A.) had discontinued his duties as Chairman, owing to ill health, returned to his post as Commission Vice-Chairman [during the interval occupied by Mr. F. W. Sargent (U.S.A.)]. It was understood that Dr. Kask as well as Mr. Dobson should continue in office until the conclusion of the Third Annual Meeting.

Panel-and Standing Committees Chairmen up to the conclusion of the Third Annual Meeting,

30 May 1953, were as follows:

Standing Committee on Finance and Administration: J. H. MacKichan (Canada)

Standing Committee on Research and Statistics: A. W. H. Needler (Canada)

Panel 1: B. Dinesen (Denmark)

Panel 2: R. Gushue (Canada)

Panel 3: R. Gushue (Canada)

Panel 4: J. H. MacKichan (Canada)

Panel 5: F. W. Sargent (U.S.A.)

4. Ratifications.

The following Signatory Governments deposited their ratifications of the Convention with the Depositary Government (U.S.A.) during the year:

The Government of Norway on 2nd July 1952

The Government of Portugal on 19th July 1952

The Government of Italy on 19th August 1952

The Government of France on 27th January 1953

Thus by now all ten Signatory Governments have deposited their instruments of ratification.

5. Panel memberships.

Panel memberships as after the ratification by France are as follows:

Country	Panel No.					Total
	1	2	3	4	5	
Canada		+	+	+	+	4
Denmark	+					1
France	+	+	+	+		4
Iceland						0
Italy	+	+	+	+		4
Norway	+					1
Portugal	+		+	+		3
Spain	+		+	+		3
United Kingdom	+		+			2
United States			+	+	+	3
TOTAL	7	3	7	6	2	25

At the third Annual Meeting Portugal became member of Panel 2 also.

6. Newsletters.

Four newsletters were distributed from headquarters in order to circulate information concerning Commission matters to Commissioners, reporters and advisers as well as to certain persons and institutions outside the Commission who would be interested in the Commission's work.

The newsletters were issued on 15 August 1952, 22 November 1952, 19 February 1953, and 28 April 1953.

7. Second Annual Report.

According to a decision at the Second Annual Meeting the "Second Annual Report for the year 1951-52" was printed. It was distributed during February, March 1953.

8. Co-operation with other International Organizations.

The Secretariat was in close contact with the Food and Agriculture Organization of the United Nations (FAO) as well as with the International Council for the Exploration of the Sea (ICES).

The Commission was represented at the Annual Meeting of ICES in Copenhagen in October 1952 by the Vice-Chairman and by the Acting Executive Secretary. The Commission's Statistician visited FAO headquarters in Rome during his travel to Europe in late fall 1952, where he had conferences with various fisheries officers.

Collaboration was maintained with ICES and FAO mainly in the field of fisheries statistics.

Between the Northwestern Subarea Committee of ICES and the Panel for Subarea 1 a close contact has been carried on, partly as to the planning of research work, and partly in order to insure a speedy and full exchange of research results.

A regular exchange of publications has been maintained with FAO and with ICES. From ICES the Commission has received a valuable collection of previous ICES-publications.

9. Larger Travels.

The Acting Executive Secretary attended the 50 Anniversary Meeting of ICES in Copenhagen in September-October 1952 (see point 8), and participated in the meetings of the Special Committee on the Commission's Research Program and of Panel 1 held in connection with the ICES Meeting. On his return trip he visited Bergen, London and Reykjavik. In these places as well as in Copenhagen he had conversations with various key persons mainly about the collecting of statistics.

In late autumn the Commission's Statistician travelled for nearly two months in Europe (France, Italy, Portugal and Spain). He contacted appropriate government officials and representatives of the fishing industry for considerations of matters concerned with the collecting of fisheries statistics. During the travel he also (see point 8) visited the FAO headquarters in Rome.

10. Commission's Research Program.

The Special Committee on the Commission's Research Program held a two day's meeting (with L. A. Walford, U.S.A., in the Chair) in Copenhagen 26-27 September 1952. The basic problems connected with fisheries researches in the Convention Area were considered: what researches to make and how to make them. Preparations for a further meeting of the Committee were made. In late January 1953 some members of the Special Committee, being together in St. Andrews (Canada) for a Panel 5 advisers' meeting, made use of that opportunity to discuss and consider the research problem in preparation for the further meetings of the Special Committee.

During a three day's meeting in New Haven on 21-23 May 1953, just in advance of the Third Annual Meeting the Special Committee prepared a report on the results of its work. This report was dealt with by the Commission during its Third Annual Meeting.

11. Panel 1 Meeting.

A meeting of the Panel for Subarea 1 was held in Copenhagen on 8 October 1952. Present were Commissioners from Denmark, Norway, Portugal, Spain and the United Kingdom with advisers, as well as observers from France, Iceland and U.S.A. Also representatives from ICES took part in the meeting. The meeting was welcomed by the Honorable K. Ree, Minister of Fisheries for Denmark.

Reports on research work carried out were delivered.

Following a consideration of the results of researches a full discussion of the research program for 1953 took place, and it was agreed that the Executive Secretary should request research programs for the year 1953 from governments participating in the work of the Subarea, and distribute such programs to the members of the Panel.

Research programs were received from all countries represented on the Panel as well as from Iceland and U.S.A., and they were distributed from headquarters early in the year of 1953.

The desirability of more detailed statistics were discussed and the Panel expressed the hope that all contracting governments would do their best to supply statistical data according to the memorandum distributed from headquarters on 1 October 1952.

12. Panel 5.

A meeting of scientific advisers to Panel 5 was held in St. Andrews (Canada) on 27 January 1953. The main subjects were problems connected with the haddock regulations in Subarea 5 and with the planning of redfish researches.

It was pointed out that the research work now initiated for the study of the effects of the Regulations would have to be carried out for a series of years and that a reasonable assessment of the full benefit of the regulations would only be possible in the course of some 5-10 years.

It was agreed that the researches already proposed were adequate to the purpose. However, to get an early appraisal of the effects of the haddock regulations special fishing with small meshed gears for the youngest age-groups should be carried out from research vessels.

The question of special and extended researches on redfish was treated, and it was agreed that an extension of the research work in Subareas 3, 4, and 5 was needed.

Finally the U.S. research program in Subarea 5 was considered. It was noted that to meet the Commission's need the period for the operation of research vessels should be extended.

On 25-26 February 1953 a meeting was held in Woods Hole, Massachusetts of the Canadian and United States scientists to assess North American oceanographic programs in the area of interest to ICNAF.

At the meeting it was recommended that a small, select, standing Committee of Oceanographers be appointed to review, plan, and coordinate hydrographic programs in the Convention Area. The Executive Secretary should arrange the time of its annual meeting so as to minimize interference with the schedules of the participants. It appears that November may be most satisfactory.

13. Haddock Regulations in Subarea 5.

The Commission's recommendation of regulations for the haddock fishery in Subarea 5 was transmitted to the Depositary Government on 15 July 1952.

On 13 March 1953 the Secretariat was notified by the Depositary Government that as the proposal for Haddock Regulations in Subarea 5 was accepted by the Governments of Canada and the United States on 13 February 1953, it would come into force for all the contracting governments on 13 June 1953.

The scientific advisers to Panel 5 had at their meeting on 27 January 1953 proposed some amendments to the methods for measuring of meshes. These were dealt with during the Annual Meeting in May 1953 (see Report of the Third Annual Meeting, p.14). The amendments to the Regulation, as adopted at the Annual Meeting, were on 11 June transmitted as proposal to the Depositary Government.

14. Research Summaries.

In accordance with Commission recommendation at the Second Annual Meeting that summaries of research should be requested from the participating countries for publication, the Secretariat asked, by circular letter of 5 December 1952, for the forwarding of such summaries.

During January-April 1953 summaries were forwarded to headquarters by Canada, Denmark, France, Iceland, Norway, Spain, United Kingdom and United States.

These summaries were distributed from headquarters in advance of the Third Annual Meeting They are published in Annual Proceedings, Part 3.

15. Research Programs.

Research programs were forwarded to headquarters partly as a result of action taken by the Chairman of the Special Committee on Commission's Research Program and partly (for Subarea 1) following resolution by Panel 1 at its Copenhagen meeting. The research programs received cover action by nine countries in the belowstated subareas:

Canada:	Subareas 2, 3 and 4
Denmark:	Subarea 1
France:	Subareas 1, 2 and 3
Iceland:	Subarea 1
Norway:	Subarea 1
Portugal:	Subareas 1 and 3
Spain:	Subareas 1, 3 and 4
U.K.:	Subarea 1
U.S.A.:	Subareas 1, 2, 3, 4 and 5

From this list it appears that researches are now carried out in all subareas of the Convention Area. In most subareas research work is carried out by several countries. This calls for a strict co-ordination of the various research programs to the effect that, as far as possible, 1) the various researches may supplement one another, and 2) that no unnecessary duplication of effort occur.

16. Collecting of Statistics.

The statistical aspect of Commission work made great progress during the year. This is due to the good understanding each country has of the requirements of the Commission, and to the full cooperation given to the Secretariat during the year. The visits of the former Executive Secretary and of the Statistician to Europe were of great value for the understanding of the fisheries industry of the member countries.

Each recommendation relative to statistics were paid attention to by the member countries.

Although all countries did not completely meet the statistical requirements, the amount of detailed information received shows a great progress. The Secretariat has received more detailed information on fishing effort. Many countries have reported their statistics compiled on a monthly basis. For 1952 a large part of the catch could not be accounted for by subareas while for 1952; according to statistics received up to date, most of the catch is reported by subareas. Countries fishing in Subarea 1 have given their statistics by Subareas Subdivisions as adopted at the Second Annual Meeting. The breakdown of the catch by size categories is made by more countries than in 1951.

Generally the progress made by countries toward meeting the requirements of the Commission is highly satisfactory.

17. Third Annual Meeting.

The Third Annual Meeting of the Commission was held in New Haven, Conn., U. S. A., 25-30 May 1953. See Part 2, p. 11.

18. Financial Statement for the year ending 30 June 1953.

The accounts of the Commission for the year ending 30 June 1953 show an appropriation of $ Can. 36,000 and a total expenditure of $32,625.22, leaving an unobligated balance of $3,374.78.

Owing to an excess of expenditures on the travel account over the original appropriation a transfer of $950 to that account from the account Personal Services was made and approved by the Commission at its Third Annual Meeting.

Pending the payment of certain contributions a transfer of $5,000 was made from the Working Capital Fund to the General Fund (in agreement with Financial Regulations Section V,1).

The accounts are summarized in the three Financial Statements in the appendix, showing (I) appropriations and expenditures, (II) income and expenditure, and (III) assets and liabilities of the General Fund and the Working Capital Fund.

The audit of the Commission's finances for the fiscal year ended 30 June 1953 was made by the Auditor General's Office of the Government of Canada on 21-24 July.

As required by Section 11 (2) of the Financial Regulations for the Commission, the Auditor General has certified that:

(a) the financial statements are in accord with the books and records of the Commission; and

(b) in my opinion, the financial transactions reflected in the statements have been in accordance with the rules and regulations, the budgetary provisions, and other applicable directives; and

(c) monies on deposit have been verified by certificate received direct from the Commission's depository.

APPENDIX

Financial Statement for the Fiscal Year ending 30 June 1953

Statement 1

Statement of budget appropriations, obligations incurred, and unobligated balances of appropriations for the fiscal year 1953

Purpose of Appropriation	Appropriated by Commission at 2nd Annual Meeting	Transfers approved by Commission at 3rd Annual Meeting	Actual appropriation	Obligations incurred (and liquidated)	Unobligated Balances of Appropriations
Personal services	$19,500	$–950	$18,550	$18,177.69	$ 372.31
Travel including subsistence	6,000	950	6,950	6,603.22	346.78
Transportation of things	300		300	106.45	193.55
Communication services	700		700	696.40	3.60
Rent and utility services	500		500	0	500.00
Other contractual services	2,000		2,000	1,906.28	93.72
Supplies and materials	1,000		1,000	857.38	142.62
Equipment	2,000		2,000	1,591.29	408.71
Annual Meeting	4,000		4,000	2,686.51	1,313.49
TOTAL	$36,000	0	$36,000	$32,625.22	$3,374.78

Statement 2

Statement of income and expenditure for the year ending 30 June 1953

Income:			
Contribution due from Spain for the year ending 30 June 1952			$ 3,180.84
Unobligated balances from year ending 30 June 1952			11,393.66
Members' contributions assessed:			
Canada	$3,772.57		
Denmark	1,338.13		
France	1,577.11		
Iceland	526.65		
Italy	3,704.86		
Norway	1,539.14		
Portugal	3,564.11		
Spain	3,289.98		
United Kingdom	2,149.62		
United States	3,224.06		
TOTAL:		24,686.23	
Less credits under Financial Regulations 5 (8)			
France's contribution	$1,577.11		
Italy's contribution	3,704.86		
		5,281.97	$19,404.26
Add to be transferred from Working Capital Fund, credits member Governments			2,021.24
TOTAL:			$36,000.00
Deduct—obligations incurred (and liquidated) (Statement 1)			32,625.22
Excess of income over obligations incurred, carried to surplus account			$.3,374.78

Statement 3

Statement of assets and liabilities as at 30 June 1953

Assets			Liabilities		
GENERAL FUND					
Cash at bank		$ 7,718.82	Credits due to Members as per Statement 2		$ 5,281.97
Contributions receivable			Surplus (Statement 2)		3,374.78
Spain 1951/52	$3,180.84		Add Contribution 1953/54		
France ½ x 1952/53	1,577.11		received from Canada		4,546.12
	$8,462.81	8,462.81	TOTAL		$13,202.87
Add transfer from			Add transfer from		
Working Capital Fund		2,021.24	Working Capital Fund		5,000.00
TOTAL:		$18,202.87	TOTAL:		$18,202.87
WORKING CAPITAL FUND					
Cash at Bank		$ 1,301.17	Credits due to Members		
Contributions receivable			from Italy	626.97	
Spain	986.67		from France	526.66	
Italy	626.97				1,153.63
France	526.66				
	$2,140.30	2,140.30	Credit due to General Fund (Statement 2)		2,021.24
TOTAL:		3,441.47			3,174.87
Add credit due from					
General Fund (pr. 15 May '53)		5,000.00	Principal of fund		5,266.60
		$8,441.47	TOTAL:		$8,441.47

PART 2

Report of the Third Annual Meeting
25 - 30 May, 1953

BY THE CHAIRMAN - J. L. KASK

1. Time and Place of Meeting.

The Third Annual Meeting of the Commission was convened at the Bingham Oceanographic Laboratory, Yale University, New Haven, Connecticut on May 25, 1953. The meeting continued on May 26, 27, 28 and 29, the final plenary session being held on May 30. The Commission meeting was preceded by a three-day meeting of the Special Committee on the Commission's research program.

2. Participants.

Commissioners were present from Canada, Denmark, France, Iceland, Italy, Norway, Portugal, Spain, the United Kingdom and the United States. Most of them were accompanied by experts and advisers. The Food and Agriculture Organization of the United Nations and the International Council for the Exploration of the Sea were represented by observers. A list of participants is attached to this report as Appendix I.

3. Opening Remarks.

The Chairman Dr. J. L. Kask, U. S., opened the meeting and read a message of welcome from the Honourable Douglas McKay, United States Secretary of the Interior. He then spoke a few words of welcome on behalf of Mr. Albert M. Day, Director of the United States Fish and Wildlife Service. The Vice Chairman, Mr. A. T. A. Dobson, U.K., expressed the Commission's appreciation for the hospitality of the United States. The Chairman then introduced Dr. Daniel Merriman, Director of the Bingham Oceanographic Laboratory, who welcomed the Commission on behalf of Yale University, and explained the arrangements for the meeting.

4. The Agenda.

The Chairman suggested that the Agenda, (Appendix II) which had been circulated to all Commissioners sixty days prior to the meeting, be adopted with the understanding that items might be taken out of turn. The United Kingdom so moved, Italy seconded, and the motion was carried.

5. Policy with Regard to Publicity for this Meeting.

The Chairman informed the Commission that the United States had loaned the services of a press officer to assist the Commission in keeping the public informed, and suggested that press releases be shown to Mr. Knollenberg (U.S.) and Dr. Martin (Canada) before issue. The Commission agreed.

6. Statement as to Ratifications.

The Executive Secretary announced ratification of the Convention since the Second Annual Meeting by Portugal on July 19, 1952, Italy on August 19, 1952, and France on January 27, 1953. All ten signatory Governments have now ratified the Convention and have become members of the Commission. The Chairman expressed a hearty welcome to the new members on behalf of the Commission.

7. Review of Panel Memberships.

The Executive Secretary reviewed the status of panel membership, inviting the Commission's attention to the desires of Portugal, France and Italy in this respect, and to the requirement for an annual review contained in Article IV,2, of the Convention. The matter was referred by the Commission to the Committee on Finance and Administration. At the third plenary session the Committee recommended that membership by France, Italy, and Portugal in Panels 1, 2, 3, and 4 be approved. This recommendation was accepted by the Commission. No other changes were made in the status of panel memberships. Panel memberships thus are:

Canada		2	3	4	5
Denmark	1				
France	1	2	3	4	
Iceland		None			
Italy	1	2	3	4	
Norway	1				
Portugal	1	2	3	4	
Spain	1		3	4	
United Kingdom	1		3		
United States			3	4	5

8. Report on Staff Matters.

The Executive Secretary had for the Commission's consideration the questions of superannuation and insurance for staff members and the date of billing. These questions were referred without comment to the Committee on Finance and Administration. At the third plenary session, the Committee presented the following recommendation:

Superannuation.

(a) The Commission is sympathetic toward the adoption of some scheme of superannuation.

(b) The Commission staff, owing to the small number of persons employed, is not eligible under ordinary group insurance of Canadian pension plans.

(c) A committee, consisting of a representative from Canada, France, Spain, the United States, with the Chairman of this Committee together with the Executive Secretary (the latter without vote) be appointed to explore thoroughly the matter of superannuation and advise all Contracting Governments prior to January 1, 1954 (and earlier if possible) and be prepared to report further to the next Annual Meeting of the Commission.

Date of Billing.

That the Commission accept the Executive Secretary's suggestion that Member Governments be billed for their 1953/1954 contributions in June 1953.

The Commission accepted these recommendations.

9. Report of Special Committee on Headquarters Site.

At its Second Annual Meeting the Commission appointed a committee consisting of the Chairman, and the representatives from Iceland and Spain, with the Executive Secretary as adviser, to explore the possibility of headquarters sites. The report of this committee, which recommended unanimously that the Commission establish its headquarters at Halifax, Nova Scotia, was read at the first plenary session and then referred to the Committee on Finance and Administration. After some study of the report, the Committee recommended to the Commission at its second plenary session that the report be accepted and that Halifax be selected as the site for the Commission's headquarters. The Commission accepted the recommendation. Mr. Bates (Canada) thanked the Commission on behalf of Canada for the honour bestowed upon it. Mr. Sargent (U.S.) moved a vote of thanks to the Headquarters Committee, which was seconded by Mr. Dobson (U.K.) and carried. The Chairman instructed the Executive Secretary to send telegrams to the officials of the City of Halifax and Dalhousie University, informing them of the decision and thanking them for their generous invitation. Telegrams were also sent to officials of the other localities which had extended invitations, declining their offers with thanks.

10. Budget.

The Commission referred to the Committee on Finance and Administration a proposed budget for 1953/1954 submitted by the Executive Secretary. The Committee examined this budget, heard explanations of it by the Executive Secretary, and at the third plenary session presented a report to the Commission recommending that it appropriate $33,130.00 for the following purposes:

Personal services	$ 19,430.00
Travelling, including subsistence	5,000.00
Transportation of things	500.00
Communication services	800.00
Rents and utilities	1,000.00
Other contractual services, including printing	2,700.00

Supplies and materials	1,000.00
Equipment	2,000.00
Annual Meeting	700.00
Total	$33,130.00

At the same time, the Committee estimated that the budget for 1954/1955 would approximate $35,000.00. At its third plenary session, the Commission adopted the budget recommended by the Committee and noted its estimate for 1954/1955.

11. Amendments to Rules of Procedure.

At its Second Annual Meeting the Commission constituted a small panel consisting of Mr. Bates (Canada), Mr. Dobson (U.K.) and Mr. Knollenberg (U.S.) to consider the Rules of Procedure and to decide whether any amendments were desirable. The recommendations of this panel were presented to the Commission at the first plenary session, having been circulated with the Agenda prior to the meeting, and were referred to the Committee on Finance and Administration without comment. The Committee studied the recommendations, amended certain of them, and recommended adoption to the Commission and the Panels of the following:

Amendments to the Rules of Procedure for the Commission.

1. Rule 3. For "may be represented" substitute the words "may be invited to be represented".
2. Rule 8 (f). Omit the first eight words and substitute the words "to arrange for the appointment of the members of Committees established".
3. Rule 13. Omit the words "and amend" and at the end insert the words "and may amend them from time to time as it thinks fit".
4. Rule 14. Delete.
5. Rule 20. After "doing so" in the fourth line insert the words "at meetings".
6. Rule 23 (a). At the end add the words "as well as the Chairman's Report of the Annual Meeting".

Amendments to the Rules of Procedure for the Panels.

1. Rule 3. Omit the words "Prior to attendance" in line 5.
2. Rule 8 (e). Omit and substitute the following: "to determine after consultation with the Commissioners of the Governments participating in the Panel the provisional order of business for every meeting and to submit it to the Commission for transmission to all Contracting Governments and Commissioners by the Executive Secretary not less than 60 days in advance of any meeting of the Panel".
4. Rule 14. After "doing so" in the fourth line insert "at meetings".

The Commission accepted these amendments at its second plenary session with the provision that the Panel amendments receive approval by all five Panels. The Panels accepted the amendments at their respective meetings.

12. Report of Special Committee on Commission's Research Program.

The Special Committee of Scientists constituted at the Second Annual Meeting presented a report containing a comprehensive research program for the Convention Area. This report was referred to the Committee on Research and Statistics, which recommended its adoption without amendment and also recommended the establishment of scientific working parties suggested in the report. The Commission accepted both recommendations at its second plenary session and approved the appointment of Dr. Gunnar Rollefsen (Norway) Chairman of the Cod and Haddock working party; Dr. Herbert W. Graham (U. S.) Chairman of the Redfish and Halibut working party; and Dr. A. W. H. Needler (Canada) Chairman of the Hydrographic working party. The Commission agreed to request each Member Government to nominate one scientist each to the working parties on Cod and Haddock and Redfish and Halibut; and two persons suitable for membership on the working party on Hydrography, from whom the Chairman of the Committee on Research and Statistics would select one member, having due regard to balance

in the working party between biologists and hydrographers. The Commission also accepted the recommendation that the working party on Hydrography be composed of both biological and hydrographical oceanographers and that this working party be asked (a) to appoint some person to explore the possibilities of using trans-Atlantic craft and weather ships in securing hydrographic data, (b) how the Commission can make use for fisheries purposes of the meteorological and hydrographic information available from the North Atlantic and how it can best collaborate with other bodies so as to better understand the forces leading to temperature and other changes, with a view to predicting them, and (c) whether the Commission's hydrographic needs can best be met by the appointment to the staff of a hydrographer, or by other means. The final report of the Special Committee of Scientists is contained in Appendix III to this report.

13. Report on Haddock Regulations in Subarea 5 including revised Research Program and Proposals for Amendment to Mesh Regulation.

The Commission referred to the Committee on Research and Statistics a report prepared by the Scientific Advisers to Panel 5, on the haddock regulation and the research program for Subarea 5 for the coming year, as well as recommendations for amendment of the haddock regulation proposed by the Scientific Advisers and submitted to the Commission by the United States. After some deliberation the Committee recommended to the Commission that it adopt the proposed amendments. At its second plenary session the Commission adopted the following amendments to its proposal for haddock regulations:

Delete the first paragraph and substitute:

"That the Contracting Governments take appropriate action to prohibit the taking of haddock (*Melanogrammus aeglefinus*) in Subarea 5 by persons under their jurisdiction with a trawl net having a mesh size less than four and one-half inches when measured wet after use, or having a mesh size when measured dry before use less than the equivalent of four and one-half inches wet measurement after use. For the purposes of this proposal, the four and one-half inch mesh size when measured wet after use shall be taken to be:

a. In the cod end of the net, the average of the measurements of each mesh in any series of fifty consecutive meshes running parallel to the long axis of the cod end and beginning at the after end of the cod end, such series to be at least ten meshes from the lacings and to be measured with a flat, wedge-shaped gauge having a taper of two inches in nine inches and a thickness of three thirty-seconds of an inch, inserted into the meshes under a pressure of not less than ten nor more than fifteen pounds, and;

b. In any part of the net other than the cod end, the average of the measurements of each mesh in any series of twenty consecutive meshes, such series to be at least ten meshes from the lacings and to be measured with a flat, wedge-shaped gauge having a taper of two inches in nine inches and a thickness o f three thirty-seconds of an inch, inserted into the meshes under a pressure of not less than ten nor more than fifteen pounds.

14. Report of the Standing Committee on Research and Statistics.

In addition to those items of business referred to it by the Commission, which have been reported upon above, the Standing Committee on Research and Statistics had before it several papers prepared by the Secretariat dealing with the Commission's statistics, publications, research, and editorial assistance. After some discussion, the Committee made the following recommendations to the Commission.

Statistics.

1. That all Contracting Governments be requested to make those observations on the changes in weight of fish from the fresh round state to the various processed states which seem, in consultation with the Commission's Statistician, to be necessary to obtain accurate statistics.

2. That the Contracting Governments be requested to submit statistics in terms of fish in the state in which they are first weighed and to provide the Commission with the conversion factors necessary to calculate the fresh round weights.

3. That, in view of the usefulness of such information, the participating Governments report statistics of landings to the Commission according to commercial size categories already in use by the industry and report annually the definition of such categories of fish sizes. (This amends Recommendation No. 2 by the Committee at the Second Annual Meeting.)

4. That the participating Governments be requested to report in summary form information on the numbers of vessels of various types and sizes fishing in the Convention Area during each year and that, to provide a basis for classification of fishing vessels, each Government report the name, gross tonnage, horsepower and type of fishing gear for each vessel fishing in the Convention Area in 1953.

5. That the request for statistics on landings and fishing effort in prescribed form as made by the Commission's Statistician on October 1, 1952, be approved in principle as a basis for future requests.

6. That, in order to provide indices of relative abundance, the Commission Secretariat be requested to arrange for the collection of more refined fishing effort data for representative types of vessels and methods of fishing.

7. That the participating Governments be requested to compile their statistics of catches and fishing effort on a monthly basis. (This reaffirms more strongly recommendation No. 7 by the Committee at the Second Annual Meeting.)

8. That, in order to provide the Commission with up-to-date information, each participating Government be urged to report, at least one month before the next Annual Meeting, statistics on its landings of each species from each Subarea, together with such other statistical information as is then available.

9. That the Commission approve of the statistical subdivisions of subareas recommended by the Sub Committee, amended to include in Subdivision F all of Subarea 1 south of Subdivision E and with Subdivision I to O re-lettered as Subdivision J to P, respectively, all subdivisions to become effective January 1, 1954 and to be regarded as permanent insofar as possible. It is understood that the Secretariat will circulate detailed descriptions of these subdivisions.

Research Reports.

1. That the present practice of obtaining summaries of research by countries for publication in the Annual Report be continued for the time being, but that there also be included in the Annual Report a brief summary of research by sub-areas, prepared by the Executive Secretary.

2. That the limits of 1,000 words for the summary of research by each country in each panel, and of 2,000 words for the entire research summary by each country be raised by 50 percent to permit research results to be described or illustrated more fully in the hope that member countries using figures would not need for their entire summaries more space than the equivalent of 3,000 words.

3. That it be the Executive Secretary's responsibility to edit summaries already received in an attempt to obtain better balance and uniformity, such editorial changes to be referred to the authors for approval before the summaries are published.

Sampling, Tagging and Planning of Hydro-graphic and Biological Research.

1. That the Commission approve of the instructions for sampling incorporated in the First Report of the Sub-Committee on Cod and Haddock for the guidance of research personnel in this field.

2. That the Commission request participating Governments to take responsibility for the

collection of tags taken by their fishermen, with information concerning the recaptures; for the payment of rewards for these tags; and for the exchange of full information concerning each tagging.

3. That the Commission instruct the Executive Secretary to prepare and distribute posters, in each language used by the member nations, with illustrations of the types of marks used, a statement concerning the purpose of tagging, a request for specific information about each recapture, and details of the reward.

4. That further research on cod in Subarea 1 proceed mainly on three lines; (a) the relation to temperature, (b) the identity of stocks, and (c) the correct measurement of mortality.

5. That the Commission approve the recommendations regarding redfish research set forth in the Report of the Sub-Committee on Redfish and Halibut.

6. That the Commission adopt the draft program of hydrographic research drawn up by the Hydrographic Sub-Committee at the Second Annual Meeting of the Commission as a satisfactory minimum for the present and request participating Governments to make available to the Commission, as soon as possible, the appropriate temperature/salinity sections with brief reports on them.

7. That, since the Commission's hydrographic problems are not circumscribed by the Commission's area boundaries, consideration must be given in the Commission's research programs to the water movements (a) to the east of Greenland, (b) to the west of Ireland, and (c) through the Florida Straits.

8. That the European countries, and the United Kingdom in particular, be requested to undertake a section approximately from the southwest of Ireland to a position about 51° N. Lat., 31° W. Long., to a depth of 500 m. and in some stations to at least 1,000 m.

9. That during their travels members of the Secretariat be asked to discuss with the various countries how best to avoid unnecessary duplication of hydrographic effort.

Publications.

(Recommended to the Commission through the Committee on Finance and Administration).

1. That the Commission's publications be established in two series, to be separately bound, one a statistical bulletin and the other an annual proceedings to contain the reports of the Commission, together with scientific papers specially prepared for the annual meeting and not published elsewhere, and an annotated list of pertinent papers published in series other than those of the Commission.

2. That the Commission request governments to submit to the Executive Secretary each year a list of published papers pertinent to the Commission's work.

3. That the Chairman of the Committee on Research and Statistics, in collaboration with the Executive Secretary, be asked to arrange for the publication by the Commission of those papers presented at each annual meeting which are most valuable, which are not being published elsewhere, and which the authors wish to have published.

Editorial Assistance.

That the matter of editorial assistance raised in the Committee's recommendation No. 23 at the Second Annual Meeting be left entirely to the discretion of the Executive Secretary.

These recommendations were accepted by the Commission at its second, third and fourth plenary sessions, with the exception of the recommendation concerning publications, which was reported to the Commission by the Committee on Finance and Administration.

The Committee on Research and Statistics met four times in all and submitted four reports. At its last session, the Committee elected Dr. C. E. Lucas (U.K.) Chairman for the coming year.

15. Report of the Standing Committee on Finance and Administration.

The Standing Committee on Finance and Administration met five times during the Third Annual Meeting and considered, in addition to the items referred to it by the Commission, several other matters of an administrative nature. It submitted five reports to the Commission, containing the following recommendations:

Auditor's Report.

> That the auditor's report, which found the financial affairs of the Commission for the year ending June 30, 1952, in good order, be accepted by the Commission.

Financial Report.

> That a provisional financial report prepared by the Executive Secretary, showing the status of the Commission's finances as of May 18, 1953, with estimates of expenditures for the remainder of the fiscal year, be accepted by the Commission as an interim report subject to audit at the end of the year.

Transfer of Appropriations.

> That the Commission approve the transfer of $950.00 to the Travel Account from other accounts for the current year.

Assessment Budget.

> That in the future the basis on which the assessments are calculated be actually on cash on hand rather than on expected income.

Publications.

> That the recommendation of the Committee on Research and Statistics with respect to the Commission's publications be accepted with the understanding that occasional special papers, such as the pamphlet already approved concerning the Fishes of the Convention Area, may be separately published upon the recommendation of the Chairman of the Committee on Research and Statistics and the Executive Secretary and with the approval of the Commission.

The Commission accepted these recommendations at its second and third plenary sessions. At its final meeting the Committee re-elected Mr. J. Howard MacKichan Chairman for the coming year.

16. Report of Copenhagen Meeting of Panel 1, October 8, 1952.

The Commission noted and approved the report of the Copenhagen Meeting of Panel 1, October 8, 1952.

17. Reports Panel 1-5 Meetings.

The Commission received and approved the reports of Panels 1 to 5. All Panels had considered reports on research and the collection of statistics in their respective subareas and all agree to base their specific research programs upon the comprehensive research program adopted by the Commission. The Commission noted that Panel 1 was to meet on October 6, 1953, in Copenhagen in connection with the meeting of the International Council for the Exploration of the Sea; that Panel 4 has constituted a group of scientific advisers to study the status of the cod and haddock fisheries in Subarea 4, and that Panel 5 had agreed to continue its group of scientific advisers. The Commission also noted the election of the following Commissioners as Chairmen of the Panels:

Panel 1—Klaus Sunnanaa (Norway)
Panel 2—L.S. Bradbury (Canada)
Panel 3—H. F. Barbier (France)
Panel 4—V. Trelles (Spain)
Panel 5—B Knollenberg (U. S. A.)

18. Special Meetings.

A symposium was held on Long-Term Changes in Hydrographic Conditions and corresponding Changes in the Abundance of Fish Stocks in the Northwest Atlantic. Lectures on the subject were given by: Clyde C. Taylor and Herbert W. Graham, Å. Vedel Tåning, and W. Templeman and A. M. Fleming. A discussion followed the lectures. The lectures are published in Part 5 of this publication.

At another meeting the following three films were shown: "Trawl in Action", introduced by R. S. Wimpenny; "Danish Seine", introduced by C. E. Lucas; "The induced spawning reflex in

hypophysectomized Fundulus", introduced by Grace Pickford (Bingham Oceanographic Laboratory).

19. Date and Place of Next Annual Meeting.

Upon the recommendation of the Committee on Finance and Administration, to which this item was referred, the Commission decided to hold its next annual meeting at Commission headquarters in Halifax, Nova Scotia, and further decided that meetings be held annually on the second Monday in June. The proposal put forward by Denmark, that temporarily the whole Commission, whenever considered justifiable, shall meet only every second year, was withdrawn by Mr. Dinesen when the subject was discussed in Committee.

20. Election of Chairman and Vice Chairman.

At its final plenary session on May 30, the Commission, on a motion by Mr. Sunnanaa (Norway), seconded by Mr. Stefansson (Iceland) and Commander Barbier (France), elected Mr. Stewart Bates, (Canada) Chairman for the next two years. On a motion by Mr. Dobson (U.K.), seconded by Mr. Trelles (Spain) and Mr. Knollenberg (U.S.), the Commission elected Commander Tavares de Almeida (Portugal) Vice Chairman for the same period. Both Mr. Bates and Commander de Almeida expressed their gratitude for the honour bestowed upon them.

21. Final Statement by the Chairman and Response.

In his concluding remarks the Chairman took occasion to express the Commission's cordial thanks to all those who had contributed to make the Meeting a success, including the Chairmen of the various Committees. Particular reference was made to the generosity of the Yale University authorities collectively and individually, as well as to that of the United States. Special mention was made of the trip to the Oyster Beds and to the Milford Laboratory. Dr. Merriman and Mr. Holden (Associate Secretary to Yale University) both addressed the meeting. The Commission endorsed the Chairman's remarks and expressed their appreciation of the service of the Headquarters staff and of the auxiliary staff loaned by the United States.

After the new Chairman and Vice Chairman had expressed their appreciation, the Meeting was adjourned.

APPENDIX I

PARTICIPANTS

Governments and International Organizations were represented by Commissioners, Advisers, or Observers, as follows:

CANADA

Commissioners:

Stewart Bates, Deputy Minister of Fisheries, Department of Fisheries, Ottawa, Ontario.

J. Howard MacKichan, General Manager of the United Maritime Fishermen, Halifax, Nova Scotia.

Louis S. Bradbury, Chairman Newfoundland Fisheries Board, St. John's, Newfoundland.

Advisers:

Dr. A. W. H. Needler, Director, Atlantic Biological Station, St. Andrews, N. B.

Dr. W. Templeman, Director, Newfoundland Fisheries Research Station, St. John's, Newfoundland.

DENMARK

Commissioners:

B. Dinesen, Under Secretary, Ministry of Fisheries, Copenhagen.

Dr. P. M. Hansen, Fisheries Biologist, Greenland Department, Copenhagen.

K. Djurhuus, Chairman Local Government, Thorshavn, Faroe Islands.

Advisers:

Dr. Å. Vedel Tåning, Head, Danish Institute for Fishery Investigations, Charlottenlund Slot.

N. Bjerregaard, Danish Fishermen's Association, Frederikshavn.

FRANCE

Commissioners:

M. Alloy, Director, Department of Marine Fisheries, Paris.

Jacques Ancellin, Chief of the Scientific and Technical Laboratories of Marine Fisheries, Boulogne s/Mer.

H. F. Barbier, Representative of the French Merchant Marine in the United States and Canada, Washington, D. C.

Advisers:

M. Quebriac, President of Central Committee of Marine Fisheries, Paris.

M. de Saint Etienne, Chief Administrator of Marine Registry, St. Pierre et Miquelon.

F. Legasse, Shipowner, General Fisheries Association, Paris.

ICELAND

Commissioner:

Unnsteinn Stefansson, Fish Industry Department, University of Iceland, Reykjavik.

ITALY

Commissioners:

Clemente Boniver, Embassy of Italy, Washington D.C.

Alberto Cupelli, Italian Consulate Agent, New Haven, Connecticut.

NORWAY

Commissioners:

K. Sunnanaa, Director of Fisheries, Directorate of Fisheries, Bergen.

Dr. G. Rollefsen, Director, Institute of Marine Research, Directorate of Fisheries, Bergen.

B. Rasmussen, Institute of Marine Research, Directorate of Fisheries, Bergen.

PORTUGAL

Commissioner:

Comm. T. de Almeida, Fishery Department, Lisbon.

Adviser:

Dr. José Mousinho Figueiredo, Institute for the Study of Fisheries, Lisbon.

SPAIN

Commissioners:

Vice-Admiral Fernando Melendez Bojard, Naval Attache to the Spanish Embassy in Washington, D.C.

V. Trelles, Consul in Charge of Commercial Affairs, Consulate General for Spain, Montreal, P.Q.

Advisers:

P. D. Espada, Technical Director, PYSBE, San Sebastian.

Gaspar Masso, Masso y Hermanos, S.A., Vigo.

UNITED KINGDOM

Commissioners:

A. T. A. Dobson, Fisheries Adviser, Ministry of Agriculture and Fisheries, London.

Dr. C. E. Lucas, Director, Marine Laboratory, Scottish Home Department, Aberdeen.

R. S. Wimpenny, Deputy Director, Fisheries Laboratory, Lowestoft.

UNITED STATES

Commissioners:

Dr. J. L. Kask, Assistant Director, Fish and Wildlife Service, Washington, D. C.

B. K. Knollenberg, Chester, Connecticut.

Francis W. Sargent, Director, Division of Marine Fisheries, Department of Conservation, Boston, Massachusetts.

Advisers:

Dr. Herbert W. Graham, Chief, North Atlantic Fishery Investigations, Fish and Wildlife Service, Woods Hole, Massachusetts.

Dr. Lionel A. Walford, Chief, Branch of Fishery Biology, Fish and Wildlife Service, Washington, D. C.

Assistant Advisers:

C. Taylor, J. Clark, G. Kelly, J. Colton; Fish and Wildlife Service, Woods Hole, Massachusetts.

Observers:

W. C. Herrington, Special Assistant to the Under Secretary for Fisheries and Wildlife, Department of State, Washington, D.C.

W. M. Terry, Office of Foreign Activities, Department of the Interior, Washington, D. C.

T. Rice, Massachusetts Fisheries Association Inc., Boston, Massachusetts.

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

Observer:

H. C. Winsor, Executive Officer, Fisheries Division, Food and Agriculture Organization of the United Nations, Rome, Italy.

INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA

Observers:

A. T. A. Dobson, President, International Council for the Exploration of the Sea, Charlottenlund Slot, Copenhagen, Denmark.

Dr. Å. Vedel Tåning, Vice President, International Council for the Exploration of the Sea, Charlottenlund Slot, Copenhagen, Denmark.

GUESTS

Mr. Holden, Associate Secretary, Yale University, New Haven, Connecticut.

Dr. W. R. Martin, Head of Groundfish Investigations, Atlantic Biological Station, St. Andrews, N. B.

Dr. D. Merriman, Director, The Bingham Oceanographic Laboratories, Yale University, New Haven, Connecticut.

SECRETARIAT

Dr. Erik M. Poulsen, Executive Secretary.
J. Cote, Statistician.
Miss J. Welsh, Secretary.
Miss T. Devine, Clerk Stenographer.

Special Assistant:

W. M. Terry, Office of Foreign Activities, Department of the Interior, Washington. D. C.

Secretarial Assistants:

Miss M. I. Flavin, Fish and Wildlife Service, Washington, D. C.

Mrs. L. Okazaki, Fish and Wildlife Service, Washington, D. C.

Miss V. Ryder, Woods Hole Laboratory, Woods Hole, Massachusetts.

Miss E. V. Smith, Fish and Wildlife Service Washington, D. C.

Miss R. F. Terrel, The Bingham Oceanographic Laboratory, Yale University, New Haven, Connecticut.

S. Townsley, Graduate Assistant in Zoology, Yale University, New Haven, Connecticut.

APPENDIX II

AGENDA

1. Introduction by Chairman.
2. Adoption of Agenda.
3. Policy with regard to publicity for this meeting.
4. Statement as to ratifications.
5. Review of panel membership.
6. Report on staff matters, including
   a. Question of superannuation and insurance for staff members.
   b. Date of billing.
7. Report of Special Committee on Headquarters Site.
8. Consideration of budget 1953/54.
9. Amendments to Rules of Procedure.
10. Report of Special Committee on Commission's Research Program.
11. Report on Haddock Regulations in Subarea 5 including revised Research Program and Proposals for Amendments to Mesh Regulations.
12. Report of Standing Committee on Research and Statistics.
13. Report of Standing Committee on Finance and Administration.
14. Report of Copenhagen meeting of Panel 1—October 8, 1952.
15. Reports of Panel 1-5 meetings.
16. Date and place of next Annual Meeting, including the following proposal from the Danish Delegation: That temporarily the whole Commission, whenever considered justifiable, shall meet only every second year.
17. Other business.
18. Election of Chairman and Vice Chairman.
19. Adjournment.

APPENDIX III

A FISHERY RESEARCH PROGRAM FOR THE NORTHWEST ATLANTIC AREA (ICNAF)

The main purpose of the Commission is to so regulate the fisheries as to avoid over-fishing and obtain the maximum long-term yield. Accordingly this research program is planned for the Commission rather than for all of oceanography.

THE SPECIES TO BE STUDIED

Work should be concentrated in the first instance upon the species of fishes listed below, order of priority differing from subarea to subarea:

cod, haddock, redfish, halibut.

Figures 1 to 4 in the appendix 4[1] show the predominant importance of cod in Subareas 1-4, of haddock in Subarea 5, and the growing importance of the redfish fishery which, since its origin in Subarea 5 eighteen years ago, has been steadily spreading northward. Halibut catches are very much smaller than those of the other species named above, but they are economically important in the north. Since the primary purpose of the Commission is concerned with management of the fisheries, cod is not of great interest in Subarea 5, nor halibut in the southern parts of the Convention Area.

THE QUESTIONS TO BE ANSWERED

The main questions with which the research program must be designed to answer are these:

1) What principal fish stocks are there, where, how divided and how now used?

2) How do intensity and method of fishing affect the stocks and the long-term yield?

3) How are the stocks affected by natural factors?

THE WORK TO BE DONE

1. Essential Records on all Fisheries which must be collected by all countries.

The Commission needs to keep current knowledge on the size, intensity and effects of all fisheries throughout the Convention Area well enough to recognize the cases that require more concentrated research effort to lay the basis for possible regulation. To carry out a continuous watch for these cases each nation must make certain minimal observations on its fisheries in the Convention Area, and must continue to do so indefinitely.

The following are minimum essential records:

a) Statistics on catch and effort. The Commission has already agreed to the essentiality of statistics giving in considerable detail the fishing effort and the catches and landings by commercial size categories of the important species by statistical areas and by months. It is necessary to record effort in such a manner that it can be studied comparatively over long periods.

b) Samples of catch for length composition. In order to recognize the effect of fishing it is necessary to record the lengths of the fish in adequate samples of catches, showing fish discarded and fish retained. This is considered essential for all the fisheries for the important species by all the participating countries throughout the Convention Area. The total range of fish caught can be sampled only at sea by specially trained observers. The sea sampling of the sizes retained should be supplemented by sampling of landings ashore.

2. Essential Records to be obtained cooperatively, not necessarily by every country.

a) To define the stocks and their movements.

Knowledge of units of stocks and their distribution and movements is necessary before the sizes of the stocks can be assessed and

[1] not printed here.

the rates of mortality and recruitment can be determined and the results applied in regulations. This may require fishing and sonic surveys by research vessels, tagging experiments, studies of meristic and other morphological features, determination of age at first maturity, fecundity, growth characteristics, distribution of parasitized fish, and biochemical attributes. The determination of spawning seasons, location of spawning concentrations, and the dispersal of larvae are important to understanding the identity of the stocks.

b) To assess size of stocks and rates of mortalities and recruitment.

This requires systematic sampling of otoliths, scales or other parts for age determinations to yield information on growth, total mortality and recruitment. Distinction between natural and fishing mortalities requires special investigations, for example tagging experiments, study of effects of various fishing intensities, and surveys of egg production.

c) To determine the effects of natural factors on abundance and distributions.

The Commission needs to know climatic and hydrographic conditions and their variations in order to relate these changes in the fishery and so distinguish between natural factors influencing the abundance and distribution of the commercial species and the effects of the fishery itself. Ultimately it is hoped to understand the changes in hydrographic conditions well enough to predict them.

3. Contributory information to be obtained as opportunity permits.

The above pertains only to information that is essential to achieving the Commission's aims. The coordination of the collection and analysis of such information is a sufficient though ambitious first step for the members to accomplish. Meanwhile, advantage should be taken of any opportunity to collect correlative information pertinent to abundance and distribution. For example, measures of basic productivity will give the rate of production of the organic material on which fish ultimately depend. Variations in productivity may be correlated with variations in recruitment and in yield. From the relative numbers of different species of organisms and from studies of their food, it can be determined what role each species plays as predator, competitor or prey.

HOW THE WORK IS TO BE COORDINATED

The research for the Commission will be carried out by national agencies in centres far removed from one another. If it is to be effective with no duplication of effort, special provision must be made for the pooling of the varied knowledge and experience, for coordination of the work, and for the development of sound agreed conclusions and recommendations. The Commission must face the fact that the great distances involved in its work will make adequate consultation between scientists costly in time and money but that such consultation is, nevertheless, essential and cannot be accomplished by correspondence.

It is proposed that coordination be achieved by the following means:

1) The establishment of working parties, responsible to the Committee on Research and Statistics, on (a) cod and haddock, (b) redfish and halibut and (c) hydrography. These working parties should examine and standardize techniques for sampling and other activities in their fields, review progress of research for the Commission, recommend changes in programs and develop conclusions. The working parties should consist of active research workers in their special fields, who will exchange cruise announcements and reports and any other material of mutual interest.

2) The provision of opportunity for working scientists to make visits to the stations and ships of other countries to observe and practice techniques and develop ideas.

3) The maintenance, through the Executive Secretary, of an up-to-date list of scientists engaged in the various branches of the Commission's work.

4) The exchange, through the Executive Secretary, each December or as soon thereafter as possible, of programs for the ensuing year.

PART 3

Summaries of Research 1952

(a) Summaries by Countries

I. Summary of Canadian Groundfish Research in the Convention Area During 1952

SUBAREA 2. BY W. TEMPLEMAN

In late September, 1952, the "Investigator II" carried out, as in September, 1951, explorations on Hamilton Inlet Bank, Labrador. A No. 36 net was used and many good catches of cod were obtained, the highest catches being at the rate of 5,000, 6,000, 9,000 and 20,000 pounds per hour's dragging. These good catches were at the centre and southern tip of the bank in 89 fathoms and at —0.93°C. and on the central eastern bulge of the bank where the largest catch was obtained in 132 to 134 fathoms and at a temperature of 1.23°C. At latitude 54°21'N. and longitude 54°35'W. in 100 fathoms and —0.30°C., American plaice were obtained at the rate of 10,000 pounds per hour's dragging and in the same catch cod were taken at the rate of 6,000 pounds per hour's dragging.

The plaice on this bank were considerably smaller than on the eastern edge of the Grand Bank but could be readily utilized commercially being mostly between 32 and 50 cm. (12½-20 in.) in length with modal sizes at about 38 cm. (15 in.) and average sizes of about 40 cm. (16 in). The cod were of moderate size, almost all being between 40 and 70 cm. (16 and 27½ in). Approximately one-third to one-quarter were between 1½ and 2½ pounds and two-thirds to three-quarters were above 2½ pounds.

A hydrographic section across the Labrador current immediately south of Hamilton Inlet Bank was taken between July 26 and August 3.

SUBAREA 3. BY W. TEMPLEMAN

Haddock.—Location of haddock catches and catches of haddock per unit effort by St. John's trawlers were investigated. Haddock landings at St. John's and trawler and "Investigator II" catches were sampled for size and scale and otolith collections. Surveys of haddock populations by otter-trawl with shrimp netting in the cod-end were carried out by the "Investigator II". Measurements were made at sea of haddock caught by commercial trawlers and on shore of haddock sizes landed from the same trips so as to obtain the sizes and numbers discarded. Age readings from scales and otoliths were carried out. Vertebral studies and observations of sex and stage of maturity of haddock were continued. Some work was done on factors for converting gutted to round weight.

Cod—Sampling of cod was continued throughout the area with otolith collections and reading for age and growth, measurements of large numbers of fish, vertebral counts, studies of stomach contents, studies of *Porrocaecum* and *Lernaeocera* parasites, and observations on stage of maturity. A large amount of exploration using four 55-foot long-lining boats resulted in the discovery of new fishing grounds several hundred miles in extent and of largely unused populations of large cod in deep water off the north-east coast of Newfoundland. Large cod were numerous in deep water near and below the border of the below-zero centigrade intermediate cold layer. Studies on age and growth of cod showed great differences in growth in the Newfoundland area. The cod of the Labrador coast at 59 cm. length were 13 years of age compared with an age of 6 years at this size on the southern part of the Grand Bank, while the Newfoundland east coast cod were intermediate. No cod tagging has been done since 1950 when 4,715 cod were tagged at St. John's and Fogo. Of these, 3.6% of the Fogo tags and 3.2% of the St. John's tags were returned in 1952. Of the tagged cod recaptured in 1952, 67 of the Fogo recaptures were from inshore Newfoundland areas and 3 from the northern half of the Grand Bank, while of the

St. John's 1952 recaptures 75 were recaptured in inshore Newfoundland areas, one in southern Labrador and 12 from the northern half of the Grand Bank. Information was obtained on conversion factors from gutted to round weight. Studies were made of yield and vitamin A values of oil from cod livers.

Redfish—Explorations of redfish populations by the "Investigator II" were continued with large numbers of measurements and sampling of the populations for vertebral number, age and growth as determined from otoliths, sex and stage of maturity and distribution of the redfish parasite *Sphyrion lumpi*. Investigations on the south-western edge of the Grand Bank in June showed, as in 1952, redfish increasing considerably in size and the percentage of females gradually increasing proceeding deeper from 100 to 200 fathoms. Researches were continued on the yield and vitamin A values of the oil from redfish livers and redfish waste.

American plaice and witch flounder—Large numbers of measurements of these species were made in catches of the "Investigator II" and by commercial trawlers. Samples were taken throughout the year and in many areas for vertebral number, fin ray count, sex and stage of maturity, and otoliths were taken for age determination.

A rough comparison was made between catches of witch flounder in otter-trawling by the "Investigator II" and those by a smaller Danish seiner in the same area. The advantage lay with the seiner.

Hydrography—Hydrographic sections from 47°latitude southward on the Grand Bank and St. Pierre Bank were covered by the "Investigator II" in March and April. In July-August sections were taken across the Labrador current off Bonavista, and all the spring stations from 47° latitude southward were repeated. The general hydrographic picture showed high spring temperatures on the Grand Bank as a hold-over from the high summer temperatures of the previous year. Meanwhile north of the Grand Bank and particularly in Labrador more and colder low temperature water existed and this gradually flowed southward during at least the early summer. Thus the bottom water on the Grand Bank was at most stations colder in July-August than in March-April.

SUBAREA 4. By A. W. H. NEEDLER & W. R. MARTIN

Part of the Canadian groundfish research in Subarea 4 is particularly of national interest: development of fishing methods such as Danish seining; exploration for unexploited inshore resources such as the flounder, *Pseudopleuronectes*; and life history studies of groundfish parasites such as *Porrocaecum*. The greater part of the research program is of international interest: identification of stocks; relation of fishery to hydrography; and studies of abundance, recruitment, growth and mortalities. Research in the latter field during 1952 is summarized below.

Identification of Stocks—A summary of the current status of our knowledge of the principal groundfish stocks in Subarea 4 has been submitted to the Commission for consideration at the Third Annual Meeting, (Part 4, I). All four of the important groundfish species (cod, haddock, redfish and halibut) include a number of stocks distinct from one another and from stocks of adjacent subareas. Migratory populations of cod and haddock, living on both inshore and offshore fishing grounds, have been observed in the eastern part of Subarea 4.

A manuscript describing the results of cod tagging from 1930 to 1940 has been prepared for publication. Some 22,000 cod were tagged and about 2,500 of these recaptured. The resulting picture of cod populations includes information on divisions of stocks and their movements in relation to hydrographic conditions, sexual maturity and feeding, all of basic value to a consideration of conservation requirements.

Four field men carried out regular sampling of commercial landings of groundfish from both inshore and offshore grounds. The resulting observations on growth, year-class strength and infection with parasites are contributing more precise definitions of the large number of populations of each of the commercially important groundfish species in Subarea 4.

Hydrography—The Atlantic Oceanographic Group carried out regular quarterly cruises in the Bay of Fundy, Scotian Shelf and Gulf of St. Lawrence areas. A long-term program of more frequent observations has been continued at nine coastal points.

Incursions of "slope water" during 1952 had a profound effect on the fishing areas of the Scotian Shelf. During the past few years surface water temperatures have reached the highest average values on record and this climatic change has had an important effect on certain fisheries. Such observations are helping to distinguish fisheries changes which are man-made, and possibly controllable, from those which are natural.

Catch Statistics—The statistical data collected for Subarea 4 have improved during 1952 with the establishment of a statistical unit of the groundfish research group at Halifax, N. S. Statistics of offshore landings, area fished and fishing effort (from offshore landing records and captains' log books) provide the basis for compilation of statistical reports, including those required by the Commission. Statistics of small-boat landings are compiled monthly by officers of the Department of Fisheries and summaries by districts are available in annual published statistics. Representative districts are sampled by the groundfish research group for data on catch as related to fishing effort.

In 1952, cod landings continued to make up the bulk of groundfish landings from Subarea 4. Landings are again close to those observed in the 1930's, having declined gradually from the peak of about 400 million pounds (200 thousand metric tons) in 1945. Fishing activity was greatly curtailed during war years and the accumulated stocks resulting from this reduced effort and from continued good recruitment and growth provided good fishing; cod abundance as measured by catch-per-effort reached a maximum in 1944 and 1945. With increased fishing effort by otter trawlers in post-war years, cod abundance has declined and this is particularly apparent for large cod of 10 pounds and over. In 1952, the abundance of large cod was at a low level throughout the year and cod landings were reduced accordingly. Landings of scrod cod ($1\frac{1}{2}$ to $2\frac{1}{2}$ lb.) continued to be small and the quantities of small cod discarded at sea were negligible.

Annual haddock landings from Subarea 4 fluctuate appreciably, now averaging about 80 million pounds (40 thousand metric tons). Regular observations at sea on commercial trawlers showed that about half the haddock caught during the months of May to September, 1952, were discarded at sea, being below marketable size.

Halibut landings from Subarea 4 average about four million pounds (two thousand metric tons). Greatly reduced halibut fishing effort during war years resulted in an accumulated stock which was quickly exploited in post-war years. In 1952, landings were still above the long-term average.

Vital Statistics—Commercial groundfish catches were again sampled regularly throughout the area for sizes and ages of fish landed. These data, together with catch and effort statistics, provide information on recruitment, growth and total mortalities. A laboratory technician made about 9,000 age determinations during 1952. A few preliminary observations on the 1952 data may be made.

Cod. Total mortality is highest off western Nova Scotia, relatively low in the Gulf of St. Lawrence and at an intermediate level on eastern and offshore Nova Scotian grounds. The 1939, 1941 and 1943 year-classes have made important contributions to offshore catches during recent years. Mortality rates appear to have increased and relatively strong year-classes now make insignificant contributions to landings of large cod (over 10 pounds or 10 years).

Haddock growth is slower than in Subarea 5 but mortality rates are not appreciably different. Great variation is found in year-class strength, the 1943 year-class being particularly important to the fishery. It is predicted that present recruitment will result in continued good availability of haddock in Subarea 4 during 1953.

II. The Danish Researches in Subarea 1 in 1952

BY PAUL HANSEN

GRONLANDS FISKERIUNDERSOGELSER, DENMARK

Two Danish research ships worked in Subarea 1 in 1952. The research ship "Dana" worked in Davis Strait from 6 July to 10 August while the research cutter "Adolf Jensen" operated in the coastal waters and in the fjords from April to October.

1. Hydrography.

Mr. Frede Hermann has worked out the hydrographic material and the results will be published in Annales Biologiques du Cons. Int. p. l'Expl. de la Mer. Eight hydrographic sections were made, in all 47 stations mainly across the offshore banks.

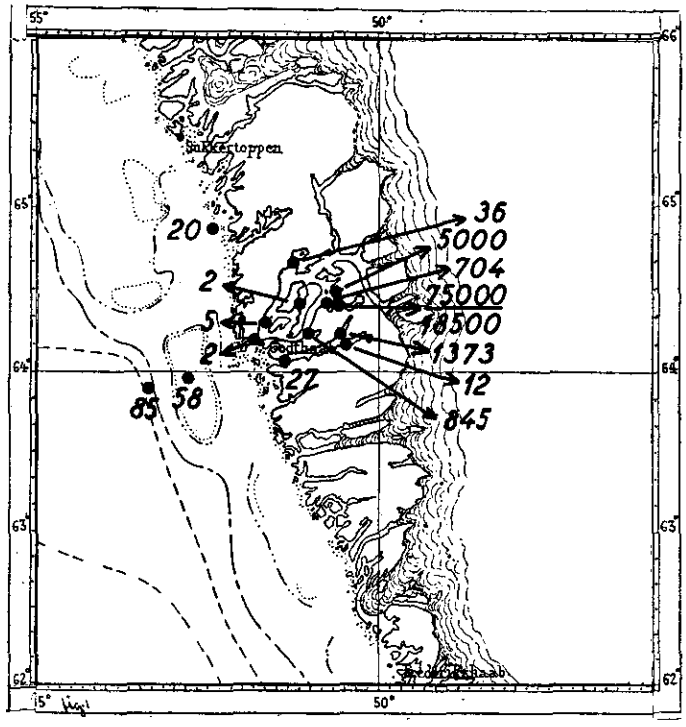

Fig. 1. Number of cod eggs taken in April—May with 1 m. stramin net per 30 minutes.

The 1952 season may be considered a cold one, especially in the southern part of Davis Strait up to Lille Hellefiske bank. A strong influx of arctic water took place in the middle of July. On the banks north of Fylla bank the arctic water was much less dominant and temperatures on the northern sections were about normal for the season.

2. Occurrence of cod eggs and larvae.

SEE FIGURES I & II

While relatively large numbers of cod eggs were taken in the inner part of Godthåb Fjord only a few were taken in the outer part of the fjord and on Fylla Bank, where the number of cod eggs taken only amounts to 58 on the middle of the bank and 85 on its western edge. In 1950 491 and 566 cod eggs were taken in the same month and on corresponding stations on Fylla Bank.

The numbers of cod larvae taken from "Dana" in July 1952 were very small compared with the numbers taken in the same month in 1950 (Ann. Biol. du Cons. Int. p. l'Expl. de la Mer 1950, pag. 38). It appears that the conditions for survival of cod larvae in Davis Strait were unfavourable in 1952 and it is therefore possible that the year-class 1952 will be a poor year-class which will not contribute very much to the output of the fishery in the future.

It appears from catches of small cod with the hand seine in the coastal region that the year-class 1950 is fairly rich, which agrees well with the comparatively large numbers of cod larvae taken by the "Dana" in Davis Strait in 1950.

3. Composition of year-classes in catches of cod.

a. The material. On the "Dana" a material of 1,500 otoliths of cod were taken at 15 different stations over the fishing banks. On the "Adolf Jensen" about 2,453 otoliths were collected in Godthåb fjord and Ameralik fjord in the Holsteinsborg district and from

localities in the Julianehåb district. Besides the collections made from the research ships, about 3,000 otolith samples were collected from the Greenlanders' catches at many different fishery stations along the coast. The total number of otolith samples collected in 1952 amounts to about 6,900. Up to the time of writing 3,885 have been read.

b. The composition of year-classes percentages in the different samples (I-XIX) are given on the map (Fig. 3).

All the samples taken by "Dana" come from cod taken with handline (IV and X-XV). The samples collected at the Greenland fishery stations come from cod taken mainly with long lines (I-III, VI-VII and XVI-XIX) or from fish yard (V). On some stations the material is derived from cod taken with different gears such as hand lines, long lines and shrimptrawl (VIII and IX).

It is seen that only three year-classes dominate in the samples from the offshore banks, (X-XV) namely the year-classes 1942, 1945 and 1947. The two last mentioned year-classes are especially rich while the year-class 1942, which was very important on the banks in three previous years (Rasmussen, Ann. Biol. 1951 pag. 51-53) is only of slight importance in 1952. Only in one sample on the western edge of Store Hellefiske bank (XI) does it amount to between 25 and 30% of the sample. In the samples from both Store and Lille Hellefiske banks (X and XI) the year-class 1947 is dominating. In the samples from Fylla bank (XIII) and Fiskenæs bank (XIV) this year-class and the year-class 1945 are of about equal importance, while on Dana bank (XV) the year-class 1947 alone amounts to less than 10 per cent.

In the samples north of 69°NL (I-IV) the composition of year-classes is quite different from that on the banks. In this region the three year-classes 1934, 1936 and 1942 are dominant.

In the samples from Umanak fjord (I) and Jakobshavn (III) the year-classes 1934 and 1936 together amount to between 30 and 40 of the total per cent while they are present in very small amounts in two other samples (II and IV). The richest year-class in this northern region is the year-class 1942. The two year-classes 1934 and 1936 have been the richest ones in West Greenland waters in a long period, from 1940 to 1949. In 1950 they were replaced by the year-class 1942.

In the coastal waters and in the fjords the two samples from the Holsteinsborg district (V and VI) are very much alike and similar to

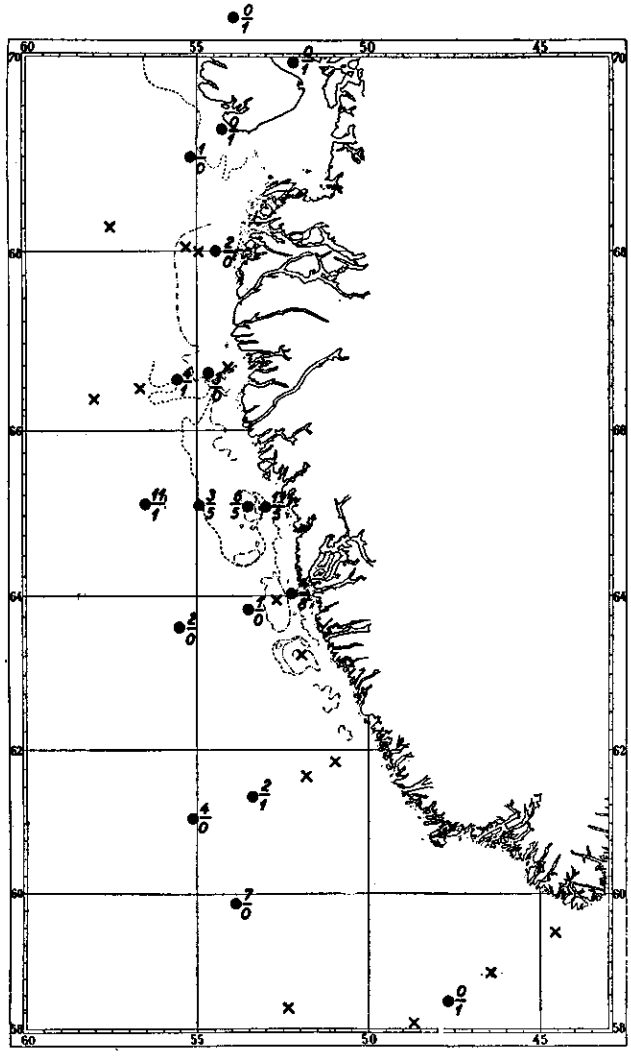

Fig. 2 Number of cod larvae caught in July with 2 m. stramin net per 30 minutes.

the samples from Store Hellefiske bank (X). The year-class 1947 is by far the richest. The sample from Sukkertoppen shows a more even age-distribution than the sample from Holsteinsborg.

Godthåb fjord (VIII) and Ameralik fjord (IX) have cod stocks which are very much alike as regard year-class composition. Especially the former has a very even distribution of year-classes which is added evidence (together with the otolith type and slow growth rate) that the fjord has a local population. This fact is also proved by tagging experiments. In Ameralik fjord (IX) as already mentioned, the composition of year-classes is very similar to Godthåb fjord. The otolith types in the two fjords are also very much alike (fjord cod type) with many secondary

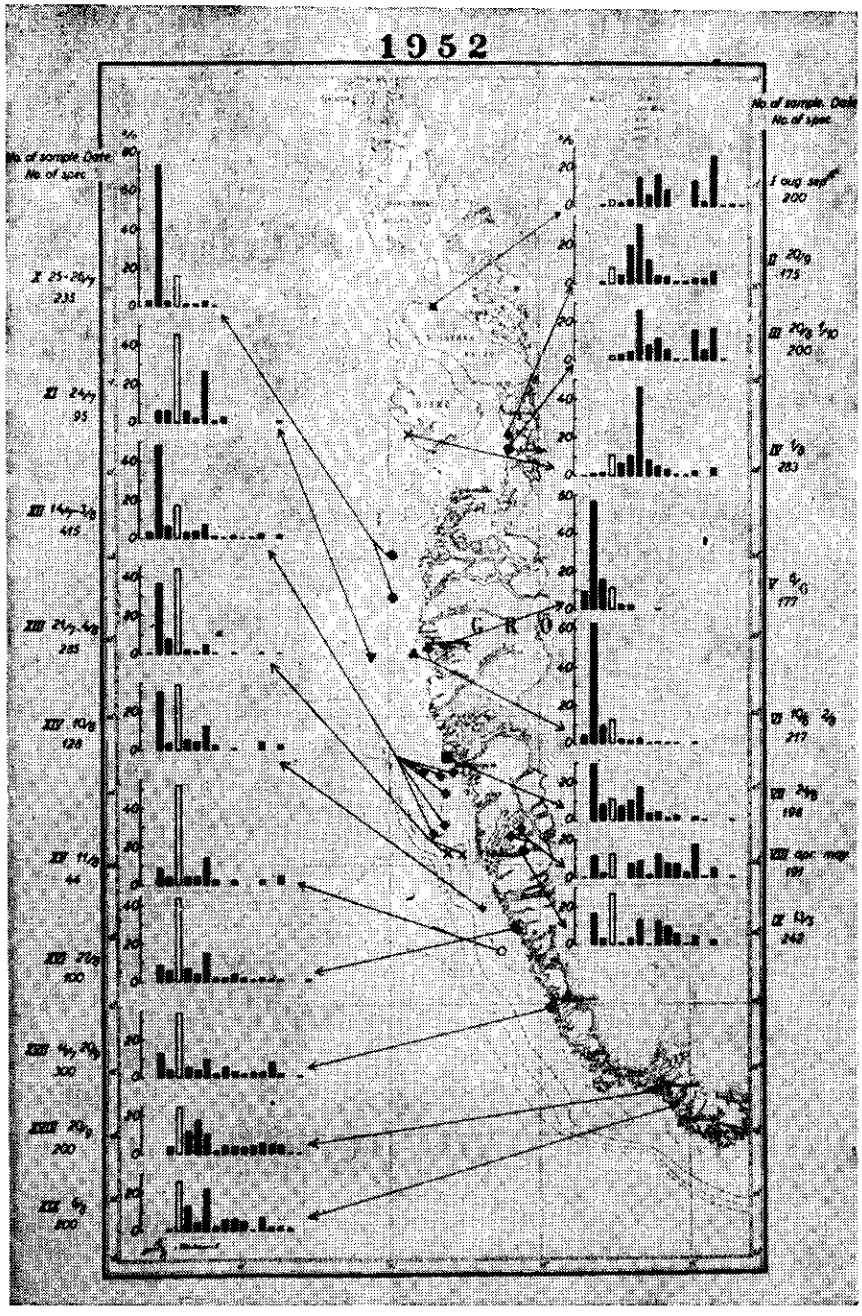

Fig. 3 Distribution in % of year-classes of cod in samples (I-XIX). Year class 1945, white columns, 1942 shaded columns.

rings, which make age determinations difficult. The growth rates, however, are different in the two fjords, being very slow in the Godthåb fjord while the Ameralik fjord cod has about the same rate as the cod on the banks (see table 1). In Ameralik fjord the cod occur only in May to June pursuing the spawning capelin. During the last part of June they disappear with the capelin from the fjord and migrate to coastal waters and the offshore banks. From a tagging experiment carried out in May 1952 seven recaptures have hitherto been procured, four came from coastal waters, one from Fylla bank and one from Store Hellefiske bank.

The two samples from Julianehåb district (XVIII and XIX) differ from the other samples south of the 69°NL by the absence of the year-class 1947. The year-class 1945 is the richest in this district. It is also remarkable that in one of the samples (XIX) the year-class 1942 amounts to a little more than 20 per cent. From a provisional study of types of otoliths it seems that there is a difference between the types from the Julianehåb district and from the northern banks which indicates two different populations of cod in the area. It has been mentioned previously that a special fjord type of otolith is found in Godthåb fjord and Ameralik fjord. This matter cannot yet be said to be wholly elucidated. A more detailed study of these important problems will be urgent in the coming years.

4. Length-measurements of cod.

In Fig. 4 are given length distributions in 5 cm. groups of cod from samples taken on the offshore banks and from two samples from coastal waters. The Roman numerals correspond with those given on the map (Fig. 3). The material consists mainly of measurements of tagged cod and of cod from which otoliths are taken. Some of the graphs are based upon a rather small number of measurements. Nevertheless the peaks of the graphs correspond fairly well with the occurrence of the different dominating year-classes in the samples.

5. The growth rate.

In table 1 are given the mean lengths of males and females of cod of the three year-classes 1947, 1945 and 1942 fished in 1952 at twelve different localities, offshore banks, coastal waters and fjords. In the same table are also given the mean lengths of cod five, seven and ten years old calculated from a large material taken in the years 1931 to 1939. It is evident that the mean lengths in 1952 are much lower than those found in the period 1931-39 indicating a slower growth

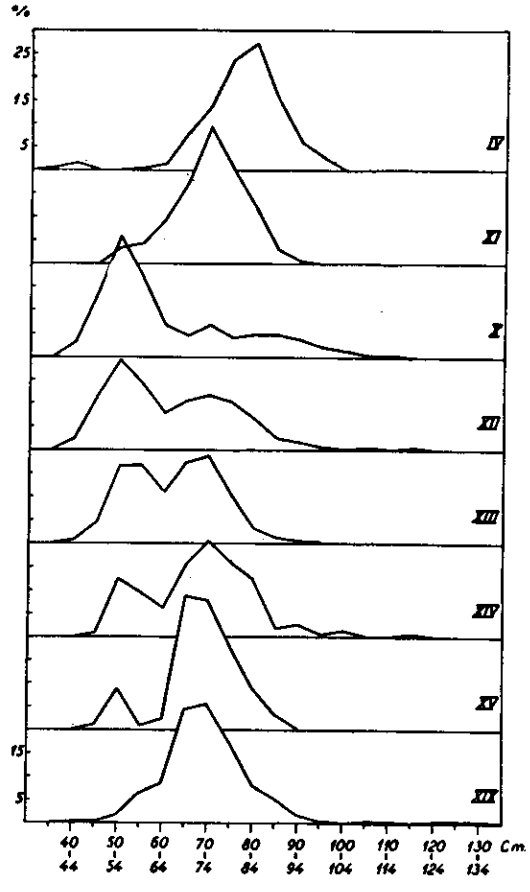

Fig. 4 Length distribution in 5 cm. groups of cod from offshore banks (X-XV) and from coastal waters (IV and XIX).

rate. The mean lengths for cod belonging to the year-class 1947 are in 1952 about the same as those found for four-year old cod in 1931-39. It is obvious that this slow growth rate affects the output of the fishery to a very high degree. The slow growth rate may probably be ascribed to an overpopulation of cod in the area, or scarcity of food or some other environmental factor (climatic change?). The very low growth rate for cod from the Godthåb fjord is remarkable.

TABLE I

MEAN LENGTHS OF THE YEAR-CLASSES 1947, 1945 and 1942 CALCULATED FROM MATERIAL FOR 1952

Locality	No. on map Fig. 3	Date	1947		1945		1942	
			m.	f.	m.	f.	m.	f.
Off Disko fjord	IV	1 Aug.			69.5(12)	69.4(20)	77.9(50)	81.5(80)
St. Hellefiske bank	X	25 and 26 July	52.3(87)	51.8(85)	71.8(17)	68.0(20)		
,, ,, ,,	XI	24 July			68.9(20)	70.7(24)	76.4(14)	80.1(12)
,, ,, ,,	VI	10-11 June	51.1(62)	52.0(60)		64.4(16)		
Lille Hellef. bank	XII	14 Jul.—3 Aug.	51.6(117)	51.8(86)	67.4(36)	68.2(37)	77.8(13)	79.3(22)
Fylla bank	XIII	21 July and 4 Aug.	54.1(48)	55.8(55)	69.5(66)	69.7(61)	78.8(6)	79.3(8)
Fiskenæs bank	XVI	10 Aug.	55.2(16)	54.6(23)	69.2(17)	72.1(27)	75.8(12)	
Dana bank	XV	11 Aug			70.8(13)	71.3(10)		
Amerdlok fjord	V	6 July	51.7(52)	52.1(49)	62.8(10)	63.3(11)		
Gothaab fjord	VIII	30 Apr.—7 May	43.8(13)	46.3(9)	61.5(8)	68.1(15)	65.2(9)	71.1(8)
Ameralik	IX	13 May	56.4(23)	55.8(17)	67.5(29)	69.7(36)	76.1(18)	77.6(14)
Julianehaab					64.7(23)	65.8(26)	75.2(11)	75.6(10)
Mean lengths of cod of corresponding ages calculated from material for the years 1931-39.								
Districts		North of 62°NL	62.1	62.1	72.0	74.2	83.3	86.7
		South of 62°NL.	59.7	59.6	72.1	73.0	78.6	80.5

6. Tagging experiments with cod.

A total of 1,545 cod were tagged on the offshore banks on board the "Dana" in 1952. The localities where tagging experiments were carried out coincide with the stations where otolith samples were taken. On the map (Fig. 3) these stations are IV (121), VI (128), X (258), XI (139), XII (525), XIII (223), XIV (101), XV (50).

In coastal waters and in fjords 2,234 cod were tagged on board "Adolf Jensen". The stations were: V (397), VIII (103), IX (337) and XIX (1,397). 153 recaptures were taken in 1952. 142 were taken in Greenland waters while 11 were taken at Iceland. The distribution by years of tagging is as follows.

TABLE II

Year of tagging	Recaptured in 1952 at Greenland	Iceland
1946	1	–
1947	—	–
1948	15	2
1949	13	2
1950	11	1
1951	28	6
1952	74	–
Total	142	11

Eleven recaptures from Iceland is a little higher than the numbers of recaptures in that area in the years after the war but nothing compared with the numbers of recaptures taken in the years before the war in the Icelandic area. In 1939 for instance 66 recaptures were made at Iceland while 64 were taken at Greenland. In 1931 the numbers were 47 at Iceland and 32 at Greenland, in 1933,57 at Iceland and 22 at Greenland and in 1934,55 at Iceland and 48 at Greenland.

Otoliths were received from eight of the eleven cod taken at Iceland in 1952. These eight cod belonged to the following year-classes:

TABLE III

Year-class	1938	1942	1943	1945
No. of cod	1	4	1	2

The most interesting recapture was taken on Store Hellefiske bank on 30 August by an Icelandic trawler. Only the tag (small Lea tag) was found unattached and lying on the deck. The cod was marked on 6 August 1949 in Umanak 70°39'N 52°00'W only 20 cm. long. Doubtless it belonged to the year-class 1947. In 1949 about 1,000 small cod were tagged with Lea tags in Disko Bay and Umanak fjord, where very large schools of small cod, mainly belonging to the

year-class 1947, were concentrated. In 1951 two recaptures of small cod tagged in North Greenland were taken in the coastal waters of South Greenland in Amerdlok fjord 66°52'N 52°52'W and at Narssak near Godthåb 63°50'N 51°38'W. The cod were marked at Ritenbenk 69°43'N 51°20'W on 27 July and at Christianshåb 68°50'N 51°10'W on 26 August. They were taken in distances from the marking place of 210 miles and 360 miles respectively. The lengths were 42 and 33 cm. at the time of tagging and they belonged to the year-classes 1943 and 1945. It appears from the experiments that there is a migration to South Greenland of small cod from North Greenland waters. It is possible that there was a very intensive migration of small cod of the year-class 1947 in 1952 from North to South Greenland coastal waters and to the offshore banks, which explains the enormous occurrence of the year-class 1947 especially on the northern banks. The lack of this year-class in the sample XI seems to indicate that these small cod are distributed only over the more shallow parts of the banks near to land and not over the deeper water over the western slopes of the banks.

III. Summary Report of the Cruise of the French Research Vessel "President Theodore Tissier" in the Region of Newfoundland and Labrador Subareas 2 and 3, August - September, 1952

BY J. ANCELLIN

OFFICE SCIENTIFIQUE ET TECHNIQUE DES PECHES MARITIMES LABORATOIRE DE BOULOGNE-SUR-MER

The oceanographic research vessel "President Theodore Tissier" sailed from Brest July 31, 1952 and crossed the Atlantic to St. John's, Newfoundland following the 48° N. Lat. From St. John's, the vessel went to the Hamilton Bank (off Labrador) and from there to the region around St. Pierre et Miquelon islands. From there, it followed the 45°30′ N.Lat. to the Grand Banks. From the Grand Banks it returned to Brest, arriving there September 18, 1952.

a. Hydrographhraphy

Sub-area 3. The hydrographic section from Brest to St. John's, Newfoundland, along the 48° N.Lat., showed the presence of a layer of warmer surface-water (temperatures above 12°C) down to an average depth of 100 m. Westwards of 22°W.Long., the layer of warmer water penetrated

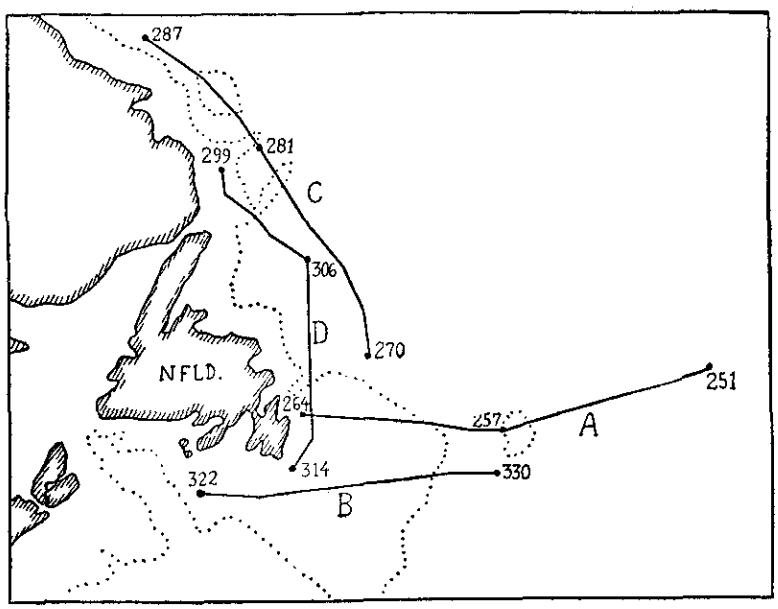

Fig. 1 Hydrographic secions (A-D) taken from "President Theodore Tissier" in the region of Newfoundland and Labrador, Aug.—Sept. 1952.

During the cruise,for which a short summary of results is given below, hydrographic observations were made, and four hydrographic sections A-D (Fig. 1) were taken. Plankton collections were made regularly along the route; moreover biometric observations and marking experiments on cod. Finally a survey was made of the Hamilton Bank (depth-soundings) and observations of the nature of the bottom.

farther down; the isotherm 12°C reached a depth of 300 m. just to the East of Flemish Cap, touching the tongue of cold water formed by the Labrador Current.

The hydrographic section from Flemish Cap to St. John's, Newfoundland showed the following characteristic features (fig. 2):

a) Warm continental water (12°-14°C) right at the surface.

b) "Cold wall":

1) at the lower edge East of Flemish Cap and of the Grand Banks, waters of 2° to 4° were observed.

2) between the Flemish Cap and the Grand Banks waters of 4° to 6°C were observed (slope water).

3) on the Great Banks from 25 m. to the bottom, arctic and continental waters were observed.

importance and also of arctic waters, was present at the edge east of the Grand Banks (section B Fig. 3).

On the whole the temperature conditions on the Grand Bank of Newfoundland in the summer of 1952 corresponded to that of a "mean" year. After a beginning warm season a rather important influx of cold water from the Labrador current occurred.

Subareas 2 and 3. The hydrographic observations made during the crossing from St. John's, Newfoundland to Hamilton Bank

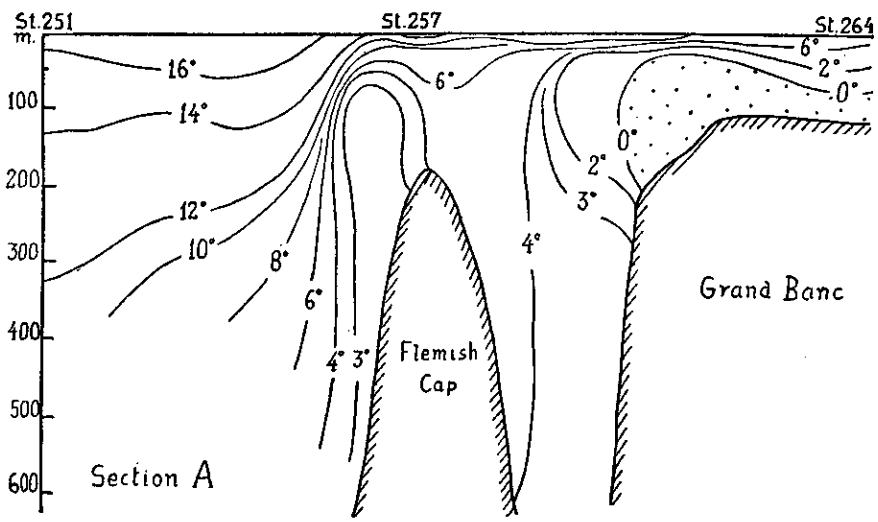

Fig. 2 Section A. Temperature.

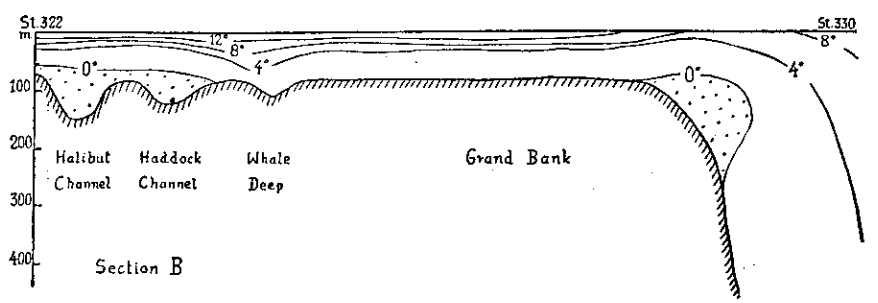

Fig. 3 Section B. Temperature.

According to the hydrographic section made during the return trip (first half of September) along the 45°30′ N.Lat., from St. Pierre Bank to the Grand Bank, arctic waters (below O°C) occupied the Halibut Channel, the Green Bank, and the Haddock Channel from 75 m. down to the bottom. A tongue of cold water of comparative

(second half of August) at a distance of 50-150 miles from the coast, have shown the presence of cold water of arctic origin (below O°C) in a large part of that region. The layer of arctic water penetrated downwards from an average depth of 50 m. to varying depths; near the coast these waters were on the bottom; farther offshore

they were withdrawing from the bottom and decreased in thickness to form an intermediate coldwater layer between two warmer layers: the seasonally warmed surface layer and the deep layer in connection with Atlantic waters. The Hamilton Bank was completely covered by a layer of arctic water about a hundred metres thick (fig. 4 and 5).

In brackets are shown the corresponding lengths of cod caught on the Grand Bank ofNewfoundland in 1951:

cod	5	years	old	49.0 cm.	(52.0 cm.)
,,	6	,,	,,	52.5 ,,	(60.0 ,,)
,,	7	,,	,,	55.0 ,,	(67.5 ,,)
,,	8	,,	,,	57.5 ,,	(75.0 ,,)

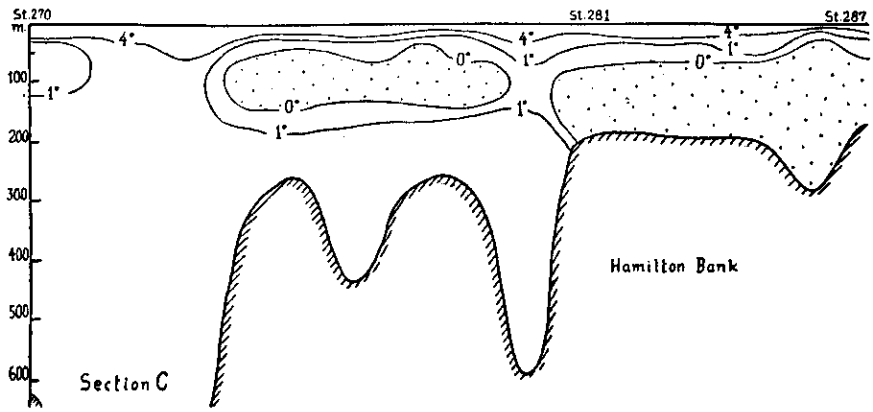

Fig. 4 Section C. Temperature

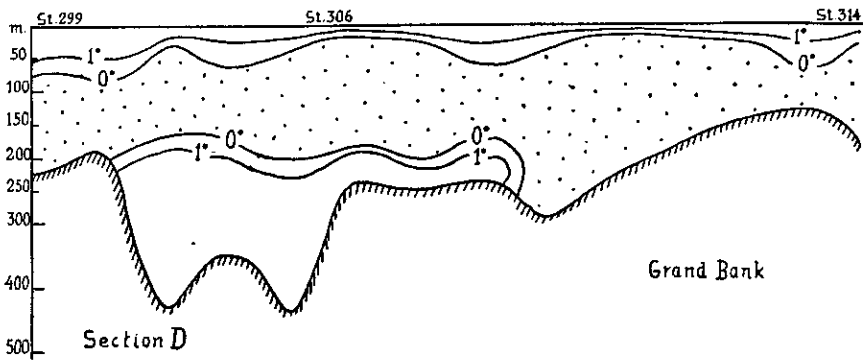

Fig. 5 Section D. Temperature.

The above observations will be supplemented by studies of the salinities.

b. Biological and biometrical observations. Tagging.

Measurements and sampling of otoliths of cod (total number 3,500) caught in trawl were carried out on the Hamilton Bank.

The length curve (Fig. 6) shows, i.a., peaks at 48, 52 and 57 cm.

The growth was studied by means of otolith readings, giving the following preliminary results.

These results confirm the observation by W. Templeman that the growth of the Grand Bank cod is far more rapid than that of the Labrador cod.

It appears that the females generally live longer than the males, and according to the distribution by size and sex it shows a predominance of females over the males starting from the 7th or 8th year. (Labrador, Grand Banks)

The growth of males and females of the Labrador stock of cod is nearly the same, the males being only 1-2 cm. smaller than the females.

The stage of maturity of most of the cod was only little advanced. The stomach contents consisted of fish (mainly capelin) and of various crustaceans.

The richest catches were obtained from the southern part of the Bank, which was as mentioned earlier, completely covered by a layer of arctic water, about 100 m. thick.

din needle passing a nylon thread through the dorsal muscles to attach the celluloid tag. This is a simple method that can be used quickly.

c. soundings—nature of bottom.

The soundings of Hamilton Bank were made by means of a recording echo-sounder, and along zigzag courses. The bottom samples

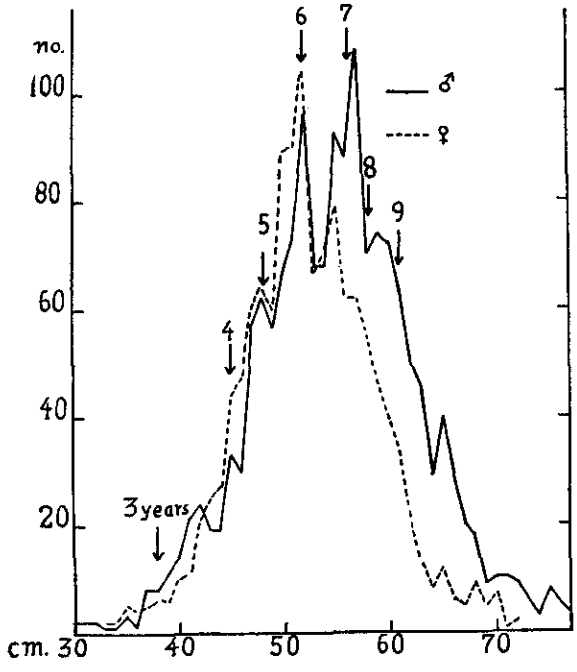

Fig. 6 Length curves of cod (males and females, 2,940 spec.), caught in trawl on the Hamilton Bank.

The tagging was carried out on line-caught cod from the waters around Iles Saint Pierre et Miquelon.

Tagging was carried out by means of a Reverwere obtained from a "Raillier du Baty" dredge. A map showing the soundings and the nature of the bottom has been prepared for the use of fishermen.

TABLE 1. AGE COMPOSITION ON THE DIFFERENT BANKS AND THE AVERAGE LENGTHS OF THE AGE-GROUPS

Age	Store Hellefiske-bank		Holsteins-borg		Fyllas-bank		Total (unweighed)		Total (weighed)
	%	cm.	%	cm.	%	cm.	%	cm.	%
2	0.2	32.0					0.1	32.0	0.1
3	0.3	35.8					0.2	35.8	0.1
4	6.9	43.5			1.3	47.1	4.2	43.9	3.2
5	63.3	52.6	38.6	55.8	44.5	54.9	54.1	53.5	50.7
6	8.4	60.3	13.0	63.0	8.3	63.3	8.7	61.7	8.7
7	15.4	70.8	26.9	72.1	35.3	71.8	24.0	71.5	27.5
8	2.0	73.0	4.5	77.7	2.9	76.2	2.5	75.0	2.7
9	1.5	74.6	1.3	73.0	2.9	75.9	2.0	75.2	2.2
10	1.5	77.4	5.8	78.8	3.7	79.7	2.7	78.8	3.1
11	0.1	74.0	2.2	83.4	0.5	81.2	0.4	81.6	0.5
12	0.2	79.7	2.2	90.2	0.1	80.0	0.3	85.6	0.3
13	0.1	86.0	1.3	90.3	0.1	106.0	0.2	92.6	0.2
14	0.1	88.0	0.4	91.0	0.1	96.0	0.1	91.7	0.1
15			0.9	87.0	0.1	89.0	0.1	87.7	0.1
16			0.4	87.0	0.3	87.3	0.1	87.3	0.2
17			0.3	95.0	—	—	0.1	95.0	0.1
18			0.9	91.0	0.1	97.0	0.1	93.0	0.1
No.	1,506		223		1,084		2,813		

banks in 1950 and 1951 (over 30%). In P. Hansen's material from 1950 this year-class dominated in all the districts sampled, but he is expecting the 1947 year-class to be of great importance in the coming years as it has been found in great quantities all along the coast. He considers this to be the biggest year-class which has occurred in the stock in recent years (Fangst og Fiske no. 7-8, 1951). In our material this year-class is of no importance (3.1%).

The uniformity of the catches from day to day is very clear. There were extensive length measurements made almost each fishing day and the daily length distribution is shown in fig. 2. All the curves have the same two top shapes. That these tops represent the year-classes 1947 and 1945 is evident from fig. 3, where the curve showing the length distribution of the age determined fish has been splitted into the various age-groups. Closer examination of fig. 2 shows that there are daily fluctuations in the proportion of the two dominating year-classes. On Store Hellefiskebank the dominance of the 1947 year-class is more constant, whereas on Fylla's Bank this dominance is not so apparent. The average lengths on Fylla's Bank are for the 1947 year-class 54.9 cm. and for the 1945 year-class 71.8 cm. and these lengths coincide with the two maxima in the length distribution. The proportion of the percentages of seven to five year old fish is 35.3: 44.5=0.79 and if we in the same way take the proportion of the length groups 70 to

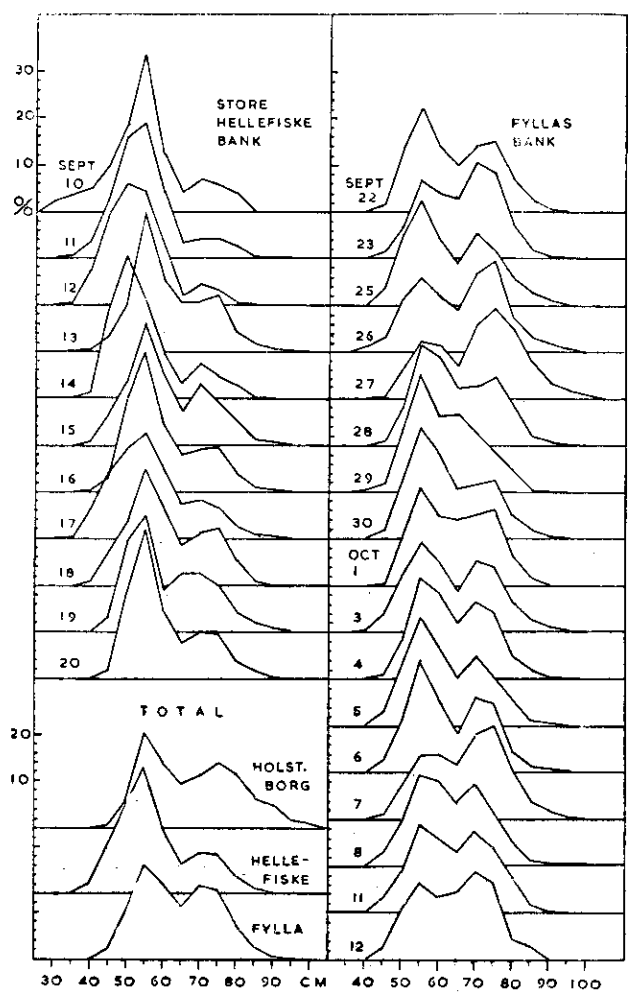

Fig. 2 The daily length distribution of catches of cod.

55 cm. we get exactly the same value 157: 199 =0.79. Without great error we can therefore compute the proportion of these two year-classes as the proportion of the 70 to the 55 cm. groups.

For the Fylla's Bank we then see that during September 22nd-27th there is a dominance of the 1945 year-class in 3 days out of 5, but according to the actual catches the ratio is 0.91 From September 28th to October 6th there is a clear dominance of the 1947 year-class, and the ratio is 0.64. Lastly from October 7th-12th there is a dominance of the 1945 year-class in 2 days out of 4, and the ratio is 1.01.

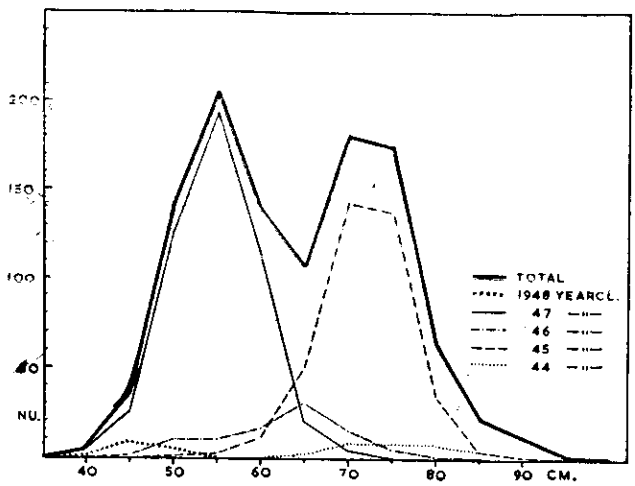

Fig. 3 The length-distribution of the different year-classes of cod.

3. The Growth.

The growth of the Greenland cod is very slow compared with the growth in Icelandic waters. The following table gives the average length (and weight) of the 1947 year-class on the Greenland Banks, Skjálfandi Bay (north Iceland) and Faxa Bay (South-west Iceland) in 1952.

Locality	Date	Length	Weight
Greenland	8-26 September	53.5 cm.	1.5 kg.
Skjálfandi Bay	19 May	61.6 cm.	2.1 kg.
Faxa Bay	24 May	81.3 cm.	4.2 kg.

The cod from Faxa Bay is 2.8 times heavier than the Greenland cod. This difference is greater than normal and must largely be due to overcrowding in the Greenland waters.

4. The Catch per-Unit-of-Effort.

Table 3 shows the number of fish caught on the different banks and the catch per unit of effort. The bottom temperatures on these banks are also given.

	Holsteinsborg	St. Hellefiske Bank	Fyllas Bank	Danas Bank	Total
No. of fish caught	25,687	125,962	156,886	12,541	321,076
Hours fished	22	143	196	9	370
No. of fish pr. hour	1,168	881	800	1,393	868
1947 year-class ,,	451	558	356	—	440
1945 ,, ,, ,,	314	136	282	—	238
Bottom temperature	4.1— 4.3°C	3.65— 4.55°C.	2.00— 2.45°C.	—	—

The trawler spent 36 days (1,864 hours) on the fishing grounds. The actual fishing was 370 hours or 42.8%. The richest catches were taken on rough bottom and therefore the figures for actual fishing are somewhat lower than usual (time spent for repair etc.).

The catch of split cod was 475.7 tons and makes 621 tons gutted with head on (which has been found for cod in Icelandic waters). This gives 167.8 tons pr. 100 hours or 17.3 tons pr. "day fishing". In 1950 the catch per "day fishing" of Icelandic trawlers fishing in salt on Icelandic grounds was 17.1 tons for the period January-December.

V. Summary of Research Work by Norway in Subarea 1 in 1952

FROM

FISKERIDIREKTORATETS HAVFORSKNINGSINSTITUTT

BERGEN

During the summer of 1952 Mr. Leif Oyen Erichsen went to West Greenland waters to collect material for the Institute of Marine Research. He worked on board the commercial long-liner "Havmann" which left the port of Færingehavn for the fishing grounds on August 7.

The Fishery and Sea Temperatures.

During the first half of August most Norwegian vessels obtained only poor catches on all the banks with their bottom long-lines. In early August the Norwegian fleet was mainly fishing the northern grounds from Disko Bank southwards to the northern edge of Lille Hellefisk Bank. The majority of the vessels had gathered on Holsteinborg Deep, situated between Store Hellefisk Bank and Lille Hellefisk Bank, where a fishery with pelagic long-lines was carried out. In this locality schools of cod were swarming in the upper strata of the sea in depths between 20 and 90 metres, with greatest concentration at 40-60 metres. The surface temperature here was about 4°C decreasing to 2.3°C at a depth of 90 metres. From the depth of 100 metres to the bottom (210 m.) the temperatures were 1.3-1.0°C.

"Havmann" was fishing with pelagic long-lines on Holsteinborg Deep during the period August 8-16. Altogether 25 skates of long-lines were hauled, the long-lines being held in position in depths of 25-75 metres by means of buoys. One skate of the pelagic gear usually contained 5,000 hooks. While fishing in this area the observer worked 8 hydrographic stations with bathythermograph and 6 stations with Nansen reversing thermometres. In table I has been listed the yield of the fishery in relation to the temperatures observed. The temperatures are as far as possible taken at the mean depth of the long-lines, usually at 50 metres.

TABLE I

Temp. °C	No. of hooks	No. of cod per 1,000 hooks
2.1—2.5	2,000	35.0
2.6—3.0	20,000	90.0
3.1—3.5	43,000	150.3
3.6—4.0	40,000	150.8
TOTAL	105,000	134.6

The figures in the table indicate that upon leaving the bottom and entering the upper strata of the sea the cod seem to prefer considerably higher temperatures than those usually found near the bottom. During the pelagic swarming the greatest concentrations of fish are found in temperatures between 3 and 4°C. Also the temperature interval 2.5-3.0°C seems to offer a satisfactory habitat. At lower temperatures the density of cod was found to be rather small. Large schools of cod were at times observed swarming near the surface, and catches made by hand-lines indicated the presence of large numbers of fish in depths of 20-40 metres.

The fact that the cod in a certain period during the summer often seek a pelagic existance cannot be seen only on the background of temperature conditions. The swarming may also be induced by the rich occurrence of food organisms in the warm upper layers. An examination of the stomach content of the cod proved that they in this period largely were feeding on pelagic organisms, particularly euphausiids, pteropods, fish larvae, sandeels, squids and small jellyfish.

The schools of pelagic cod gradually thinned out, and by August 20 most of the fishing vessels had resumed their fishery with bottom lines. From now on till the end of the season the "Havmann" was fishing together with other Norwegian long-liners in the area near Disko. The "Havmann" made two trips to that area, one during August 17-30, the second during September 8-29.

The fishery was carried out with bottom long-lines in depths from 35 to 370 metres. Temperature conditions were noted by means of bathythermograph (40 stations) and reversing thermometres (18 stations).

In table II are listed the catches made at various temperature intervals. Where temperature readings at both ends of the long-line are at hand the mean value of the two readings have been used. In cases where bottom temperatures are lacking we have used observations taken near by on the same day. With the changes in bottom temperatures often encountered on the northern banks such a procedure may of course give room for some error.

TABLE II

Temp. °C	No. of hooks	No. of cod per 1,000 hooks
0.6—1.0	48,000	78.4
1.1—1.5	96,000	70.3
1.6—2.0	113,500	84.6
2.1—2.5	151,500	100.8
2.6—3.0	23,000	86.8
3.1—3.5	10,000	91.8
3.6—4.0	8,000	84.5
4.1—4.5	10,500	74.3
TOTAL	466,500	86.2

Catches above average are made at temperatures between 2.1 and 3.5°C, the largest quantities being taken at the interval 2.1-2.5°C. In bottom water below 1.5°C or above 4.0°C the occurrence of cod is apparently less dense. The food organisms consumed by the cod roaming over the bottom have a different character than those of the pelagic cod previously mentioned. In the stomach contents of the bottom fish particularly the deep sea prawn predominate, but also crabs, amphipods, fish and sea cucumbers form part of the food.

From the material at hand we may also gain a picture of the temperature situation in general in the Disko Bank area in September. Above the shallow section of the bank, where the depths are less than 100 metres, the sea was clearly stratified. The surface temperatures were generally 4-5°C, at 50-60 metres there was a sharply defined transition layer where the temperature dropped from 4 to 2°C. On some spots the transition layer touched the bottom, and here the cod seemed to be concentrated in larger numbers. On other spots the bank was covered with water of temperatures below 1°C, and here the fishery mostly gave poor results. On the southern slope of Disko Bank was found a thin surface layer with temperatures above 5°C. Between 30 and 100 metres the temperature range was 2.5-2.0°C, and the bottom temperature at 150-180 metres about 1.7°C. In this northern area no pelgaic schools of cod were observed.

Intensity and Yield of Fishery.

In 1952 the majority of the Norwegian long-liners started their fishery off West Greenland in early June. Faroese vessels reported to have fished very well with long-lines on Fiskenæs Bank and Banan Bank in May. In June the line-caught cod were rather small-sized and in poor condition. From early July to the end of the season the Norwegian vessels were mostly engaged in fishing on the northern banks where the cod were larger and the condition of the fish steadily improving.

Vessels fishing out from ports in Norway generally make two trips to Greenland waters, while those fishing from the base at Færingehavn make 4-5 trips on the banks. The long-line fishery is carried on with great intensity. A single skate of long-lines carry 3-5,000 hooks and stretches over 3-5 miles of ground. Ordinarily 4-5 skates, or 16-20,000 hooks are fished every day.

To indicate the yield of the fishery at different temperatures the term "catch per 1,000 hooks" has been used. It seems natural to use the same term as a unit of effort in discussing the yield of the fishery in the various localities and at different periods. In Table III are listed the catches per unit of effort on the last two trips made by the "Havmann".

TABLE III

Locality	August 8-30 No. of hooks	August 8-30 No. of cod per 1,000 hooks	Sept. 7-29 No. of hooks	Sept. 7-29 No of cod per 1,000 hooks
Holsteinborg Deep	105,000	135	—	—
Store Hellefisk	23,500	79	—	—
Disko Deep	60,000	114	16,000	86
South Disko Bank	31,000	79	—	—
West Disko Bank	56,000	92	96,000	58
North Disko Bank	—	—	192,000	85
TOTAL	275,500	110	304,000	77

In August the best yield per unit of effort was obtained during the pelagic long-lining on Holsteinborg Deep. Here the daily catch of the vessel averages 2,700 fish using 20,000 hooks. Disregarding the pelagic fishery, the yield on bottom lines averages 95 cod per 1,000 hooks, or 1,520-1,900 cod during an average day's fishing.

In September the yield of the long-line fishery shows a decreasing tendency. The average catch per day's fishing is between 1,230 and 1,540 cod. However, the fish caught on the last trip were large and fat which could still make the fishery remunerative. During the second trip a total of 23,265 cod were caught which yielded 40 tons of cured fish. If we apply the conversion factors used in Norway (cured weight +70% gives gutted weight, the latter +40% gives round fresh weight) the mean weight of the freshly caught cod should be 4.1 kg. This figure, however, seems somewhat too high. The question of a correct conversion factor for Greenland cod will be more closely examined during next year's fishery.

Size and Age of Line-Caught Cod 1952.

From the northern banks a total of 2,500 otoliths and length measurements were collected. At present, however, only about half the age material has been read. The age composition and the mean lengths of the different age groups found among the line-caught cod are listed in table IV.

TABLE IV

Age	Holsteinborg Deep		Store Hellefisk Bank		Disko Deep		South Disko Bank		West Disko Bank		Total	
	%	cm.	%	cm.	%	cm.	%	cm.	%	cm.	%	cm.
5	0.5	53.0	—	—	0.3	52.0	1.4	47.5	—	—	0.5	50.6
6	0.9	59.0	—	—	1.9	62.7	2.0	60.0	0.8	60.0	1.3	60.9
7	8.3	69.4	—	—	6.0	67.3	4.8	63.3	3.3	66.0	6.2	67.9
8	4.6	72.4	10.0	69.5	5.7	69.7	2.0	74.0	2.5	75.0	4.5	71.5
9	9.4	72.8	12.5	70.0	13.3	71.9	17.0	73 3	14.0	72.4	12.3	72.4
10	37.2	75.9	35.0	74.8	46.5	75.2	26.6	77.6	33.0	76.4	38.0	75.8
11	8.3	77.1	5.0	85.0	8.9	77.9	13.0	81.4	13.2	78.8	9.5	78.5
12	7.1	78.7	—	—	6.2	78.8	4.8	82.9	7.4	82.6	6.2	79.7
13	4.6	78.9	12.5	76.2	3.5	81.5	8.2	83.1	6.6	83.5	5.3	80.8
14	—	—	—	—	—	—	—	—	—	—	—	—
15	2.3	80.5	2.5	72.0	0.6	78.5	1.4	84.0	0.8	83.0	1.6	80.3
16	10.3	83.1	15.0	85.7	3.8	83.6	8.2	84.3	5.8	84.7	7.8	83.7
17	1.6	84.7	—	—	1.0	88.3	2.0	84.3	1.7	86.5	1.4	85.6
18	4.7	85.9	5.0	87.0	2.9	85.0	8.8	89.1	9.1	89.1	5.2	87.3
19	—	—	2.5	137.0	—	—	—	—	0.8	100.0	0.2	118.5
20	—	—	—	—	—	—	0.7	90.0	0.8	85.0	0.2	87.5
21	—	—	—	—	—	—	0.7	98.0	—	—	0.1	98.0

From the table it can be seen that large and old fish can still be found on the northern banks. The tendency of the old fish to gather on the northern banks has also been noted in the previous year (Norw. Rep. to ICNAF 1951). In 1952 we find a distinct division in regard to the mean age of the fish on Disko Bank and cod caught further south. The mean age of the Disko cod is 11.5 years. In Disko Deep the figure is 10.3 at Holsteinborg Deep 11.1 years. A corresponding difference is also found in the mean size of the fish. The cod from Disko Bank have a mean length of 78.5 cm., those from other localities about 76 cm.

In fig. 1 is illustrated the age composition of line-caught cod in the years 1948-1952. In 1948 the two year-classes 1934 and 1936 dominated the fishery. These cod were by then respecti-

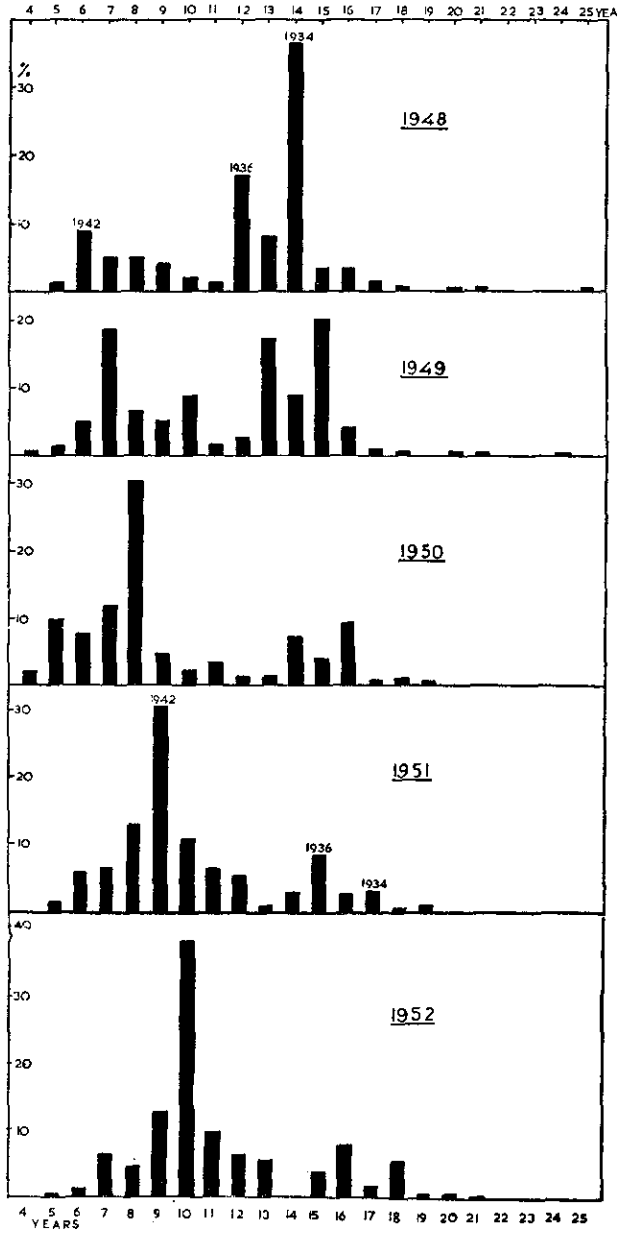

Fig. 1 Age composition of line-caught cod from west Greenland banks, 1948-52.

vely 14 and 12 years of age. In the subsequent years these two year-classes decreased in strength. in 1952, when the same fish were respectively 18 and 16 years old, they were, however, still able to contribute materially to the fishery. Of particular interest is the fact that the pelagic cod from Holsteinborg contained a total of 15 per cent of these year-classes. In last year's report it was mentioned that the Holsteinborg cod differed from the ordinary bank cod in their general appearance. It was this particular type of fish which also made up the pelagic catches in 1952.

Fig. 1 further shows that it is the year-class 1942 which has dominated in the line catches during the last years. In 1951 this year-class contributed 31 per cent to the total catch. In 1952 its contribution increased to 38 per cent. Thus it is still the 1942-class which more than ever is the bearing factor in the line fishery.

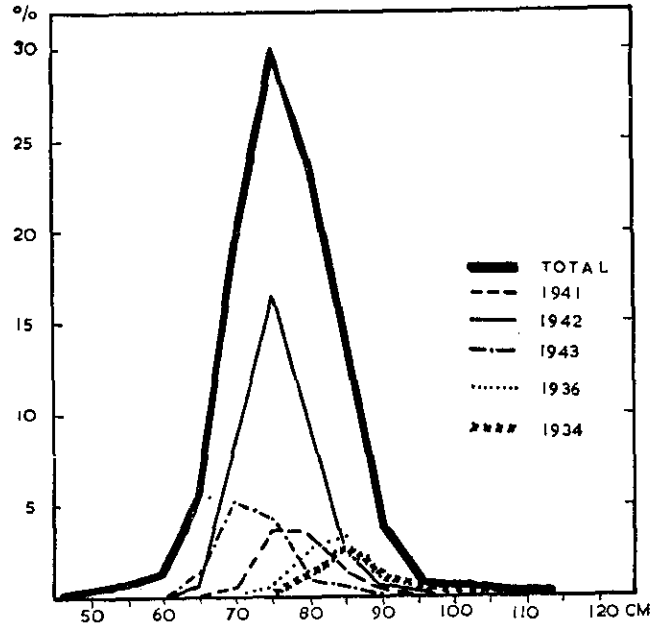

Fig. 2 Size-distribution in various year-classes of line caught cod from west Greenland banks 1952.

Fig. 2 shows the size distribution of the line-caught fish, both totally and for the most important year-classes. It is the solid strength of the year-class 1942 which chiefly determines the total mean size of the line-caught fish. The five year-classes shown in fig. 2, viz. 1941, 1942, 1943, 1934 and 1936 constitute altogether 72.8 per cent of the catch in 1952.

The total Norwegian catch at Greenland in 1952 was approximately 9,400 tons of cured cod, of 22,400 tons of cod in fresh round weight. This corresponds to a catch of about 5.5 million cod. Of these numbers the 1942-class is responsible for its share of 2,1 million cod.

In last year's report mention was made of the 1947 year-class. This brood was deemed to be unusually rich and is expected to give a large yield in the future. The year-class is by now 5 years old, but the fish have not as yet reached such a size that they readily take the hooks. In two years, from 1950 to 1952, this brood has grown from 30 to 51 cm. With a similar rate of growth the 1947-class can be expected to enter the catches in higher degree by 1953.

VI. A Brief Preliminary Report of the Scientific Spanish Researches Made in Newfoundland Waters Aboard the Trawler Vendeval, February-March, 1953

FORWARDED BY THE SPANISH DELEGATION TO THE ANNUAL MEETING, MAY, 1953

A complete report of the results will only be available at a later date when the material has been fully treated.

Date: February and March, 1953

Zone: South of Great Bank
Bank of St. Pierre
Brief Exploration in Banquereau

Personnel: Mr. D. Rafael Lopez Costa, Chemist of the Spanish Institute of Oceanography
Mr. D. Olegario Rodriquez Martin, Biologist on the General Direction of Fisheries

The following species were made the objects of researches:

Cod	*Gadus callarias*
Haddock	*Melanogrammus aeglefinus*
Pollock	*Pollachius virens*
White Hake	*Phycis tenuis*

These species are the only ones of interest to our fishermen, because they are best suited for preservation in salt. Halibut or redfish, were not fished for, and a quantity of these present in the net caused the fishermen to seek other fishing grounds.

Problems that faced us:

a—size. The most current sizes have been:

	Great Bank	St. Pierre
Cod	40 to 60 cms.	55 to 65 cms.
Haddock	40 to 50 ,,	45 to 55 ,,
Pollock	60 to 70 ,,	60 to 70 ,,
White Hake	70 to 80 ,,	70 to 80 ,,

Fish of size less than 40 cms. were not used.

b—sexual stage

Sexual Stage		I	II	III	IV	V	VI	Total of fish observed
Cod	male	107	4	7	—	9	—	127
	female	95	10	5	—	6	—	116
Haddock	male	8	7	14	13	4	—	46
	female	9	5	6	15	4	—	39
Pollock	male	1	1	—	1	1	24	28
	female	2	2	—	—	—	13	17
White Hake	male	—	—	2	15	5	—	22
	female	1	13	5	4	6	1	30

c—food. Collections of stomach contents were made for each of four species for later examinations.

d— conversion factors

To estimate the loss of weight weighings of samples of fish were carried out for each of the following treatments:

a) by cleansing, by heading, gutting and boning.
b) by salting.

The fish weighed were marked with metal tags so that they could be weighed again upon their arrival at port.

The loss in weight by cleansing of the four species can be anticipated as follows:

Cod	Large	(94 to 130 cms.)	49% loss
	Medium	(70 to 94 ,,)	43.5% ,,
	Small	(37 to 66 ,,)	42.1% ,,
Haddock			37% ,,
Pollock			32% ,,
White Hake			47.6% ,,

The losses by salting will be reported on later.

e—plankton

Surface plankton was collected with special indicator, as well as with silk sleeve, the samples are being kept in formaldehyde for later studies.

f—scales and otholiths

For all four species mentioned scales and otoliths were collected in connection with individual measurements and determinations of stage of maturity.

g—observations on water temperature both from the surface and from various deeper water layers were made.

h—salinity Samples of water were collected.

i—phosphorus Determinations of contents per cubic meter were carried out during the cruise.

VII. Summary of Research Work Carried Out by the United Kingdom in the I.C.N.A.F. Area in 1952

BY C. E. LUCAS AND R. S. WIMPENNY

The English Research Vessel "ERNEST HOLT" made two cruises to South Greenland during the autumn of 1952, one of which took place in the Commission's Panel 1 area, when banks between Cape Farewell and Cape Desolation were explored during the period 4-16 September.

The banks proved to be on the whole difficult for trawling. East of Cape Desolation the bottom was found to be uneven and rough with areas of promising looking bottom, judging by sounder records, limited to the crests of the banks off Sermersok, Nanortalik and Kitsigsut. Even here, however, the trawl was frequently damaged, probably by boulders deposited by the many icebergs which melt here. Polyzoa and hydrocorallines were also responsible for net damage on some grounds.

In addition to the icebergs, which are widespread in this region and necessitated the carrying of radar and searchlights, fog and strong currents of up to 40 sea miles a day were common physical hazards making navigation and handling the trawl difficult. Furthermore, the sky was overcast for long periods and astronomical fixes were infrequent—an added difficulty on a coastline little known and often inaccurately charted. Inaccuracies checked have been forwarded to the Admiralty together with sketches of coastwise features.

LORAN cover extends over most of the area and appears to be a valuable navigational aid although only limited trials were carried out by the "ERNEST HOLT".

Cod was the predominant species caught, but fishing was patchy with the paying quantities only found feeding in water of below 2°C., i.e. comparable with those found in the Barents Sea around Bear Island and Hope Island. Capelin, amphipods, and some euphausids were the most important food organisms—as also at Bear Island and Hope Island in the Barents Sea—but the Cape Farewell area fish included a greater proportion of benthic animals, especially many species of amphipods, in their diet. Low length/age figures suggest a relatively poor feeding area although insufficient material is available on other factors affecting growth. Age composition of the shoals from the five grounds visited was remarkably uniform and show that the shoals were composed largely of one rich year-class, that of 1945, 7½ years old when sampled, which represented approximately 60% of the total sample. Otolith structure was also constant and tended to confirm that the shoals in this area belonged to one population. However no sampling was carried out up the west coast and it is not known where the northern limit of this population may lie and indeed its relationship to the western bank population requires investigation.

256 cod were tagged with Lea tags (a residue from the Holt's 1951 Bear Island marking experiment) and released in the Cape Farewell region in order to test the hypothesis that the mature and first time spawners would spawn at Iceland.

Eight tagged fish were recaptured within the first month after release in the same general area by British trawlers.

Landing statistics indicate heavy fishing in the same region through the season until the end of 1952, and market sampling for otoliths has been instituted in order to continue the study of races in southern Greenland waters.

No further work was done by the United Kingdom within the Commission's area, but the halibut stocks in the waters between Greenland and Iceland have been investigated and some of the results may be relevant.

In one paper,[1] the statistics of the Scottish halibut line fishery off East Greenland during the period 1930-49 were reviewed; they illustrate

[1] McIntyre, A. D. Mar. Res. Scot., 1952 No. 1.

the fluctuations in effort and stock over the period, in comparison with similar statistics for grounds off the west coast of Iceland and elsewhere. Catches increased considerably after the war attaining in the period 1945-49 annual averages per hundred lines fishing which compared favourably with those of the early 1930's. Comparison with data from the other grounds makes it seem probable that the high catches obtained after the war may not have been due so much to reduced fishing as to natural fluctuations in the stock.

Another paper[2] gives an account of the food of halibut from various grounds in the North Atlantic, including those to the west of Iceland, and it may be that the results bear some relation to the feeding of halibut in the Commission's area. The large halibut caught there were feeding on only a few species of organisms, and one species, *Sebastes marinus*, constituted over 75 per cent of the food by volume. In view of our knowledge of the food of *Sebastes* itself, this confirms the belief that the halibut probably leaves the sea-bed in pursuit of its food; in these waters, at least, the benthos formed only a relatively small proportion of the food, and that mainly of the younger halibut.

[2] McIntyre, A. D. Mar. Res. Scot., 1952, No. 3.

VIII. United States Research in Convention Area During 1952

BY HERBERT W. GRAHAM, WOODS HOLE, MASS.

Research by the Woods Hole Laboratory of the Fish and Wildlife Service in the Convention Area was directed chiefly toward the two most important species in United States landings, namely, haddock and redfish. In addition to the general studies of factors affecting the abundance, effort was directed toward methods to evaluate the effect of mesh regulation on the haddock fishery. Food habits of haddock and the general biology of whiting were new projects initiated during the year. All of the investigations were confined to Subarea 5 except the meristic studies of haddock which extended throughout Subareas 3, 4 and 5; and the redfish abundance studies which extended into Subarea 4.

Haddock:

Georges Bank Population in 1952. The 1948 year-class which dominated the fishery in 1951 as two-year-olds, causing a preponderance of scrod over large haddock, failed to maintain its dominance in 1952. The incoming year-class of 1950 appeared in great numbers and assumed dominance of the fishery throughout 1952. The proportion of scrod over large haddock in the landings was greater even than in 1951. For the third consecutive year landings of scrod have exceeded landings of large haddock. Total landings from Georges Bank during 1952 were about 80 million pounds, a decrease of 11.5 million pounds from the 1951 landings. With the same amount of fishing as in 1952 the predicted catch for 1953 is 78 million pounds, the lowest catch since 1945.

Racial Studies. Vertebral numbers of haddock in the area from Georges Bank to Newfoundland are being studied to determine the racial identity or degree of independence of the stocks. The Fisheries Research Board of Canada and the United States Fish and Wildlife Service have pooled their data in this study. Over 11,000 counts from 16 fishing grounds have been made at various times since 1932. Determination of age, length, sex and other characters have been made with the most recent samples.

The results show haddock vertebral numbers to vary generally with geographic location and with water temperature. The number of vertebrae increases from Georges Bank north eastward to eastern Nova Scotia. This increase is correlated with decreasing water temperatures during the spawning season. Newfoundland haddock, however, have fewer vertebrae than Georges Bank haddock. Although this breaks the latitudinal relationship, the temperature correlation still holds since spawning occurs at a later date on the Grand Banks when the water temperature is higher than on Georges Banks during the spawning season.

Significant differences exist between vertebral numbers of haddock of New England, Nova Scotia, and Newfoundland, indicating that the haddock of these three major regions are relatively independent. Also, the eastern Nova Scotian stock appears to be distinct from the western Nova Scotian stock.

Various year-classes have different numbers of vertebrae. Significant negative correlations were found between the average number of vertebrae of individual year-classes from Georges and Browns Banks and the temperature of the water during spawning.

Distribution in Subarea 5. Analysis of the **Albatross III** census data revealed many interesting features of haddock distribution on Georges Bank and surrounding waters. During the summer months there is a concentration of large haddock in depths over 90 fathoms. These are not fished by the commercial fleet. These fish migrate to shoaler water during the spring spawning season when they appear in the commercial catches. Large concentrations of zero-age haddock in the Gulf of Maine and off Long Island for years of strong year-classes on Georges Bank indicate that the Georges Bank stock is recruited at least in part from surrounding waters in Subarea 5. During summer and fall few haddock were found between 60 and 90 fathoms indicating that some ecological factor, possibly food, was unfavourable in that zone.

Sampling at Sea on Commercial Trawlers. The sea sampling program initiated in 1951 was continued throughout 1952. Data were collected on the numbers, sizes, and ages of haddock discarded relative to those landed. In addition to data required for assessment of the mesh regulation information is obtained in this program on the sub-commercial sizes of haddock which is valuable in prediction of future catches.

Food Habits. An investigation of the food habits of haddock in Subarea 5 was started in an attempt to determine whether available food is important in relation to fluctuations in abundance.

Effects of Mesh Regulation. In preliminary investigation of the effect of mesh regulation on the Georges Bank haddock fishery, calculations were based on mortality rates and fishing efforts averaged over an 18-year period. The first step in increasing mesh size is designed primarily to effect a maximum escape of small haddock with a minimum reduction in landings of marketable sizes. The optimum age of first capture to obtain a maximum equilibrium yield at various levels of fishing intensity has been the subject of more recent investigations.

Yield-isopleth diagrams (Beverton, R. J. H., "Some observations on the principles and methods of fishery regulation." International Council Exploration de la Mer, 1952) have been constructed for the Georges Bank fishery for assumed instantaneous natural mortality rates of 0.1 and 0.2, the latter corresponding to the 15 percent annual natural mortality assumed in earlier calculations.

The eumetric yield curve for the Georges Bank fishery, based on 15 percent annual natural mortality, indicates that at the present level of fishing intensity the optimum age of first capture lies between 3 and $3\frac{1}{2}$ years. The first step in mesh regulation will make the age of first capture about $2\frac{1}{2}$ years, so that a maximum equilibrium yield would require about 50 percent increase in fishing effort. The computations further show that at any age of first capture lying between 3 and 4 years, the yield will be fairly close to maximum over a range of fishing efforts varying from 75 to 200 percent of the present average annual effort.

Among steps taken to observe the actual effect of the regulation, 8 large trawlers for which fishing records exist for a period of years, will be licensed to fish with the small mesh presently in use. The composition of the catch of these boats will be compared to that of similar boats using the large mesh.

The ultimate evaluation of the regulation is considered to be the yield, during their lifetime in the fishery, of year-classes of similar size before and after regulation.

Selectivity of Otter Trawl Meshes:

Covered codend experiments were conducted to determine the sizes of haddock which will escape through meshes of different sizes. Four codends were tested. Alternate tow experiments demonstrated that in moderate concentrations of fish the cover had no effect on the escape of haddock through the codend meshes.

The codends were constructed of 50 yard, 4 thread, double Manilla twine. When new meshes were first used the meshes decreased in size due to shrinkage of the fibers upon wetting. After the first tow the meshes enlarged due to tightening of the knots. The degree of enlargement depended upon the size of the catches and was greater in the after part of the codend where the strain was greatest in hauling. The 50 percent selection points for various mesh sizes (measured internally) were computed on the basis of the average size of mesh for the entire codend.

Internal mesh size (In.)	50 per cent selection size (cm.)
3 3/4	32.0
4-1/8	35.5
4-1/2	37.3
4-3/4	39.9

Whiting:

A study of the general biology of the whiting in Subarea 5 was initiated. Particular interest is centered on the relation of whiting to haddock. The immediate problems to be solved have to do with the number of species involved in the whiting fishery and the determination of age.

Redfish:

Age and Growth. Studies of age and growth have been based on examination of samples of the commercial catch from the Gulf of Maine. Otoliths have been used for most age readings, although scales are used for younger fish. A critical analysis of the validity of the age readings has been hampered by the lack of very small redfish in the market samples. Fishing for small specimens with a research vessel is expected to supply these sizes.

Present interpretation of otolith rings indicates a very slow growth for the redfish. The rate of growth appears to vary from one bank to the other.

Abundance. An index of abundance has been developed and the relative abundance of redfish determined for areas in the Gulf of Maine and on the Nova Scotian shelf. In these areas the catches per unit of effort have decreased as fishing has intensified.

Spawning. Preliminary studies have been made of the spawning habits of redfish in Subareas 4 and 5. With samples from the commercial catch information has been obtained on the time of egg fertilization, length of incubation period, time of spawning of live fry, fecundity as shown by numbers of eggs developed and numbers of fry spawned, and size at maturity. The time of spawning as well as the other aspects of reproduction seem to vary from place to place, each stock appearing to have its particular characteristics.

Migration. Studies of the incidence of the copepod ectoparasite *Sphyrion* indicate that there is no appreciable migration of redfish out of the Gulf of Maine to other areas. Other evidence indicates that there are no extensive migrations of any of the stocks. There is no evidence of a spawning migration. Conclusions regarding the movements of the redfish, however, are only preliminary. More studies must be made and attention directed toward devising some method of tagging.

Distribution of Groundfish.

The problem of sampling groundfish populations by otter trawl has been examined in the light of the data collected by the **Albatross III** during the census cruises of 1948-1951.

Groundfish are found in schools of varying size, either because of natural gregariousness or because of environmental factors such as favorable patches of bottom. Random sampling of such heterogeneously distributed populations results in many tows with small numbers or no fish, as well as occasional tows with great numbers of a particular species. If the occurrence of the numbers of tows with 0, 1, 2 . . . . n fish of a species is plotted, the resulting distribution is fitted to a high degree of probability by the negative binominal distribution. The indices, k, of these distributions, in the census data, are always less than 1.0, so that the variences are never less than the mean plus the mean squared. Estimates of density based on the observed mean are, then, subject to so much error as to be of little use.

It was further found that the occurrence of numbers of species per tow is a Poisson distribution, suggesting that the species found in the area sampled tend to be distributed independently of each other.

As a corollary of these distributions, it was further found that the species and numbers of individuals of each were distributed in the logarithmic distribution, as theoretically required.

A simple model to account for the observed distributions is suggested. If one postulates heterogeneity of distribution of each species, so that the mean number observed varies from sample to sample as an Eulerian variable, and that each species is distributed or moves about independently of other species, the three observed distributions may be derived in a manner parallel to that demonstrated by Quenouille (Biometrics, vol. 5, no. 2, 1949).

(b) Summary by Subareas

COMPILED BY THE EXECUTIVE SECRETARY

Summaries of research for 1952 have been received from Canada, Denmark, France, Iceland, Norway, Spain, United Kingdom, and United States. In the table below is shown the distribution of research by subareas and by countries.

Subarea	1	2	3	4	5
Canada		++	++	++	
Denmark	++				
France		++	++		
Iceland	+				
Norway	+				
Spain			+	+	
United Kingdom (15)	++				
United States (13)			+	++++	

++indicates researches from special research vessels.

It should be noted that this table in no way accounts for the quantity of work carried out, but only for the dispersion of it.

In 1952 research work was carried out in all 5 subareas, and in all of them research vessels from one or more countries were operating. Further, biologists were working from commercial vessels in most of the subareas. These facts stress the necessity of a combined planning of the researches in order that possible gaps may be filled up and duplication of work avoided.

Subarea 1.

Research vessel "Dana" (Denmark), 6 July-10 August.

Research vessel "Ad. S. Jensen" (Denmark), April-Oct.

Research vessel "Ernest Holt" (England), 4-16 Sept.

Further collections of data and material were made by specially designated persons from the commercial trawler "Pétur Halldórsson" (Iceland) the long-liner "Havmann" (Norway), Aug.-Sept.

a. Hydrography.

8 sections across the offshore Greenland banks (Denmark).
Observations between Kap Farvel and Kap Desolation (United Kingdom).
Observations of sea temperatures in connection with fishing for cod (Norway and United Kingdom).

The 1952 season is reported a cold one, especially in the southern part of the area as far north as to Lille Hellefiske Banke.

b. The Fishes.

Plankton collections with Hensen net and fishing with ringtrawl for eggs and larvae, mainly cod and redfish, were carried out from the "Dana".

The small numbers of cod larvae found are reported to indicate a poor survival year.

Young cod. From investigations in the coastal area it appears that the 1950 year-class of cod is fairly rich.

Age composition of samples of commercially caught cod is reported by all 4 countries. The Danish and Norwegian analyses from the Disco Area in the north show a predominance of older cod, various year-classes between 1932 and 1942. Farther south the 1947 year-class predominates in Danish and Icelandic catches, the 1945 year-class comes next. In the area south of Godthåb again somewhat older year-classes, 1945 and 1942 are predominating in British, Danish, and Icelandic catches.

In the Norwegian line-fishing the 1942 year-class was predominating.

Taggings of cod were carried out by Denmark and by U. K.

By Norway and by U. K. a special study of the dependence of cod fishing on sea temperature was made. The Norwegian line fishing for pelagic cod yielded the biggest catches at 2.5°C-4.0°C, for bottom living cod at 2.1°C-2.5°C. The trawl fishing (U.K.) yielded the best catches (of feeding cod) at temperatures just below 2°C.

The results by the separate countries as to age-and size distribution of cod are in fairly good agreement. This shows that the material collected is sufficient for a proper judgment of the age composition. Thus the possibility exists that the research vessels could leave part of the collecting of such material to the biologists on board commercial fishing vessels, thus saving additional time for those researches which can be carried out only from the specially equipped research vessels.

Subarea 2.

Research vessel "Investigator II" (Canada), July-Sept.

Research vessel "President Theodore Tissier" (France), Aug.-Sept.

a. **Hydrography.**

A section across the Labrador current south of Hamilton Bank, 26 July-3 August (Canada).

A section along the Hamilton Bank, August (France).

The Hamilton Bank was in August completely covered by arctic water (below 0°C.) up to 50 m. from the surface.

b. **The Fishes.**

Cod. Measurements and samplings of otoliths were carried out on the Hamilton Bank. The French researches in August and the Canadian in September both showed the biggest trawl-catches on the southern part of the Bank in arctic water (below 0°C). In somewhat warmer water (1.2°C) on the eastern bulge of the Bank large catches were made in late September.

American plaice (*Hippoglossoides platessoides*) were caught in large quantities on the Bank in depth of nearly 200 m. in September in water of −0.3°C.

It should be noted that the researches of the two countries nearly coincide as to time. Thus they sooner control than supplement one another.

For general results of the last years' researches cfr. **Templeman**: "Knowledge of Divisions of Stocks of Cod, Haddock, Redfish and American Plaice of Subareas 3 and 2" (Part 4, p. 62).

Subarea 3.

Research vessel "Investigator II" (Canada), throughout the year.
Research vessel "President Theodore Tissier" (France), Aug.-Sept.
Trawler "Vendeval" (Spain), Feb.-March 1953.

a. **Hydrography.**

Sections, Southern Great Bank and St. Pierre Bank, March-April and July-Aug., and across the Labrador current off Bonavista, July-Aug. (Canada).
Sections, N. E. of Newfoundland, across the Great Bank and St. Pierre Bank and E. to about 39°W.Long., Aug.-Sept. (France).
Observations on temperature, salinity and content of phosphates, southern Grand Bank and St. Pierre Bank, Feb.-March 1953 (Spain).

High spring temperatures were found on the Banks. The temperature during summer was lower owing to intermingling with cold water from the north. In August the temperature of the bottom water on the northern part of the Bank was below 0°C, in September on the central part of the Bank just above 0°C, in the channels, however, water below zero was still present.

b. **The Fishes.**

The Canadian research was centered on cod, haddock, redfish, and to a minor degree American plaice and witch, *Glyptocephalus cynoglossus*, covering stages from the young fish to the commercial sizes.

The growth-rate of cod from the southern part of the great Bank was twice that of the cod off the Labrador coast, the growth-rate of the Newfoundland East coast was intermediate. New rich fishing grounds for cod were discovered in deep water N. E. of Newfoundland.

Redfish on the S.W. edge of the Banks showed increasing individual size and percentage of females going from shallower (180 m.) to deeper water (350 m.).

Tagging of cod was carried out around Iles St. Pierre et Miquelon (by France).

By Spain measurements (incl. collections of scales and otoliths) and observations on maturity and food of cod, haddock, pollock, and white hake were carried out.

By U.S.A. meristic studies of haddock were carried out.

Subarea 4.

Research vessel "Sackville" (Canada) for periods.

Research vessel "Investigator II" (Canada) for periods.

Various smaller research vessels (Canada) for periods.

Research vessel "Albatross III" (U.S.A.) for periods.

Further experimental work (by Canada) from commercial fishing vessels.

Trawler "Vendeval" (Spain), Feb.-March 1953.

a. Hydrography.

Regular, quarterly cruises in the Bay of Fundy, on the Scotian Shelf, and in the Gulf of St. Lawrence (Canada).

A considerable incursion of "slope water" to the Scotian Shelf was observed. During the last years the surface temperature reached the highest mean values recorded. This climatic change has a great effect on certain fisheries.

Hydrographic observations on Banquereau, Feb.-March 1953 (Spain).

b. The Fishes.

The researches by Canada have dealt mainly with the question of identification of stocks and of the discreteness of the stocks on the various fishing grounds. Studies on abundance, recruitment, growth and mortality were also carried out.

Refined statistical data on catch and effort were used combined with the biological researches.

Landings of cod are decreasing gradually from the peak in 1945. Also the abundance, measured by catch per effort, has diminished. The decline is particularly apparent for large cod.

The researches of haddock show a smaller growth-rate in Subarea 4 than in 5. The variation in strength of year-classes is big. Based on calculation of recruitment a good availability of haddock in Subarea 4 is predicted for 1953.

During May-September half of the commercial catch of haddock is discarded at sea, being below marketable size.

Meristic studies of haddock were carried out by U.S.A., and the relative abundance of redfish for areas of the Nova Scotian Shelf was determined. The catches of redfish per unit of effort have decreased.

The reports for Subarea 4 show a decline in abundance of cod and redfish. As these species account for ¾ of the total landings of groundfish from the subarea such a decline is a serious matter calling for the closest attention.

For cod and haddock, as well as for redfish, a decline in abundance and for a decrease in individual size have been observed. This may be signs of a beginning overfishing calling for a close watch to be kept of the stocks of these fishes.

For general results of the last years' research cfr. **W. R. Martin**: "Identification of Major Groundfish Stocks in Subarea 4 of the Northwest Atlantic Convention Area". (Part 4, I, p. 57).

Subarea 5.

Research vessel "Albatross III" (U.S.A.) for periods.

Observations and fishing experiments were carried out from commercial vessels.

a. Hydrography.

No reporting.

b. The Fishes.

The research efforts were directed chiefly towards the two most important species, haddock and redfish.

The rich 1948 year-class of haddock failed to maintain its dominance in 1952. Landings of scrod have now for three years exceeded landings of large haddock. Total landings were less than in 1951. The catch in 1953 is predicted to be still lower.

Significant differences as to vertebral numbers indicate that the haddock stocks in the areas off New England, Nova Scotia and Newfoundland are relatively independent.

The researches show that areas of the Gulf of Maine and off Long Island are important nursery grounds from where recruitment of the haddock stock on Georges Bank takes place.

Extensive investigations bearing on the effects of the proposed haddock regulations are carried out.

The abundance of redfish in the Gulf of Maine is decreasing. The spawning of redfish in Subareas 4 and 5 was studied.

PART 4

Scientific Papers Specially Prepared for the Annual Meeting

May, 1953

I. Identification of Major Groundfish Stocks in Subarea 4 of the Northwest Atlantic Convention Area

BY W. R. MARTIN

Conservation of the groundfish fishery of the northwest Atlantic ocean is the primary purpose of the International Commission for the Northwest Atlantic Fisheries. Intelligent management of this large fishery will be based firstly on knowledge of the definition of the various groundfish stocks, their distribution and movements, and secondly on an understanding of the factors which determine the size of the catch which may be taken from these stocks. It is of particular interest to determine whether or not regulation of fishing may be expected to increase the long-term yield of any particular groundfish stock.

The development of a mesh regulation for haddock fishing in Subarea 5 has been based on definition of the haddock stock and an assessment of the effect of fishing on its yield to the fishery. Similar information must be collected for the major cod, haddock, redfish and halibut stocks throughout the Convention Area.

It is the purpose of this report to review, in summary form, the status of our knowledge of the principal groundfish stocks in Subarea 4 as a basis or considering conservation requirements. Current investigations of the population dynamics of the various groundfish stocks will provide the basis for determining optimum fishing conditions and the relation of present fishing practices to an objective of "best use" of our groundfish resources. Such basic information as natural and fishing mortalities is not well understood but definition of groundfish stocks in Subarea 4 has been studied for some 25 years and the results of investigations of the more important species (cod, haddock, redfish and halibut) may be described.

Cod

Cod is the most important groundfish species in Subarea 4 with landings normally exceeding 200 million pounds (100,000 metric tons). The greatest part of the catch is landed in Canada and more than half of these landings are taken by inshore, small-boat fishermen. The cod is a cold-water species and its relative importance increases from south to north in Subarea 4. Only about a quarter of the groundfish landings are cod at the mouth of the Bay of Fundy but cod make up more than 90% of the groundfish landed along the Gaspé coast and the north shore of the Gulf of St. Lawrence.

The deep-water Fundian Channel between Georges and Browns Banks and the still deeper Laurentian Channel between St. Pierre Bank and Banquereau are barriers to the movement of cod. Except for occasional movements of individual cod across these channels we may consider that the cod populations along the Nova Scotian Coast, in the Western Gulf of St. Lawrence, and on the Nova Scotian offshore banks are resident in Subarea 4. The evidence is based on about 2,500 returns from some 22,000 cod tagged in Subarea 4 and on vertebral counts on about 28,000 cod sampled throughout this "Maritime" fishing area. More recent observations on growth, year-class strength and infection with parasites support the results of pre-war tagging and vertebral-count investigations.

Within Subarea 4 we find a great many cod populations which may be divided into a number of major stocks:

(1) **Western Nova Scotia**—Resident populations show restricted movement and do not

mix with eastern or offshore cod. The number of vertebrae is low, about 10% are infected with cod-worms, growth rate is very rapid, total mortality is high with very few cod living more than seven years, and spawning is in April and May.

(2) **Central Nova Scotia**—Resident populations show very restricted movement. The majority are spring spawners with a vertebral count which is higher than that of western Nova Scotia but lower than that to the east and offshore. A population of fall-spawning cod with a low vertebral count is also found in the Halifax area.

(3) **Eastern Nova Scotia**— Populations show a movement offshore in winter and inshore in summer. Vertebral number is high and about 20% are infected with cod-worms. Growth rate is slower than that of western Nova Scotia cod and mortality is lower. Cod are not fully recruited to the fishery until they are about five years old and they are of little importance to the fishery beyond an age of 11 years.

(4) **Western Cape Breton**—The cod population along the western Cape Breton coast moves out of the Gulf of St. Lawrence in the autumn, winters just north of the offshore banks and returns around Cape North to the Chéticamp area again in the spring. Spawning has been observed in June and July.

(5) **Offshore Nova Scotia**—Both resident and migratory populations of cod are found on Nova Scotian offshore banks. Some appear to be resident on the banks all year round, others move in along the eastern Nova Scotian shore in summer months and still others move into Cape Breton and the Gulf of St. Lawrence as far as Gaspé for the summer. The cod on eastern banks show a greater tendency to migrate Gulfwards than those on the western banks. Western banks fish spawn in early spring and eastern banks fish in late spring. Vertebral number is high and cod-worm incidence low in offshore cod. Growth is slower than that of western Nova Scotia but faster than that of Gulf cod. Most fish are contributed to the fishery at from five to twelve years of age. Offshore catches increase during winter months with concentration of fish in deeper water and offshore movement of cod from inshore waters and the Gulf.

(6) **Southern Gulf of St. Lawrence**—Populations in the Prince Edward Island area restrict their movements to the southern Gulf of St. Lawrence. Tag returns outside the Gulf are few, vertebral count is low and infection with cod-worms high. Growth is slow and cod contribute to the fishery for several years (ages four to fourteen). Spawning is somewhat later in the Gulf (July-August) than on Nova Scotia grounds.

(7) **Gaspe**—Cod are abundant in the Gaspé area of the Gulf. Vertebral counts are higher than those of the southern Gulf and similar to those of Cape Breton and Nova Scotia offshore banks. Worm incidence is high with over 50% of the cod infected with the cod-worm. Growth rate is slow and fish as old as 15 years are common in the catches. The average age of cod in Gaspé landings is about eight years. Spawning occurs in late summer (August-September).

(8) **Eastern Gulf of St. Lawrence**—Cod populations on the Newfoundland side of the Gulf are quite distinct from those taken west of the Laurentian Channel. Tagging shows a migration out of the Gulf in winter and a return movement to the Gulf in spring. Vertebral counts are lower than those observed at Cape Breton. Large, old, slow-growing cod are taken from this eastern Gulf area.

(9) **Northern Gulf of St. Lawrence**—Slow-growing cod are found in the northern Gulf. They do not mix with those taken west of the Laurentian Channel.

To sum up, we find a great many populations of cod in Subarea 4. In general, each major stock of cod remains distinct. Those off central and western Nova Scotia move relatively little. Those in the Gaspé and Prince Edward Island areas move greater distances but remain year-round in the Gulf. Cape Breton cod show a seasonal movement offshore in the autumn and Gulfwards in the spring. Resident offshore cod populations are augmented by migrating cod during late autumn and winter months. These migrating cod move inshore and into the Gulf

along the Laurentian Channel during summer months. The populations along the Newfoundland shore and Quebec north shore of the Gulf of St. Lawrence are distinct from those taken west of the Laurentian Channel.

Haddock

Haddock landings from Subarea 4 are smaller than those from Subarea 5 but the relative abundance of haddock varies widely. Landings reached a peak of 130 million pounds (60,000 metric tons) in 1930 and fell below 40 million pounds (18,000 metric tons) in 1942. Canada and United States fishermen share the catch about equally. Haddock are normally found in warmer water than cod and at more southerly latitudes. They are abundant all along the Nova Scotian coast in both inshore and offshore waters but landings from the Prince Edward Island, New Brunswick, Quebec and Newfoundland areas of the Gulf of St. Lawrence are very small.

Haddock are more restricted to bottom than cod and for this reason Subarea 4 haddock are even more sharply separated from those in Subareas 3 and 5 than noted above for cod. Subarea 5 haddock have a low vertebral count, a high growth rate and a high mortality rate, with few living beyond an age of seven years. Subarea 3 haddock also have a low vertebral count but growth rate is low and older fish are caught. Relative strength of year-classes varies widely in haddock and it is of interest to note that the dominant year-classes differ in these three subareas. In recent years the landings have shown the following outstanding year-classes: 1942 in Subarea 3, 1943 in Subarea 4 and 1948 in Subarea 5. The evidence based on some 25,000 vertebral counts, 14,000 tagged haddock and an intensive postwar program of sampling for sizes and ages of the commercial catch demonstrates clearly that Subarea 4 haddock are distinct from the haddock of adjacent subareas except for some mixing with Subarea 5 haddock in the Bay of Fundy area.

Investigations of the haddock in Subarea 4 have shown a number of major haddock stocks:

(1) **Northern Bay of Fundy**—Haddock appear during summer months in this region. Their growth is rapid and tagging has demonstrated that they are related to the New England stock.

(2) **Southern Bay of Fundy**—The population off western Nova Scotia moves into the Bay of Fundy during summer months and away from the Bay in winter. Growth is slower than that of northern Bay of Fundy haddock. During the past few years the 1939, 1943 and 1945 year-classes have contributed a major part of the landings.

(3) **Browns Bank**—The slowest-growing haddock of Subarea 4 are resident on Browns Bank. This population differs sharply from that of Georges Bank to the west and LaHave Bank to the east.

(4) **Southwestern Nova Scotia**—The haddock of this area are faster-growing than those of Browns but slower-growing than haddock taken from offshore and eastern Nova Scotia grounds. Tagging results show an eastward drift of large haddock from the area but most tag returns were taken from the area of tagging, indicating a resident stock. The 1943 year-class dominated landings from 1947 through 1951. Western Nova Scotia haddock are heavier at any given length than those taken to the east.

(5) **Eastern Nova Scotia**—A population of fast growing young haddock in this area shows seasonal offshore movement. Vertebral count is higher than that of western Nova Scotia. The 1943 year-class in particular and lately the 1947 brood have dominated landings during recent years.

(6) **Cape Breton**—The haddock of the southern Gulf of St. Lawrence are large, fast-growing fish which move out of the Gulf in the late autumn to return again in late spring. They winter on Nova Scotian offshore banks. These haddock move into the Gulf close to shore around Cape Breton with the oldest haddock moving first. These migratory haddock grow quickly (although more slowly than those of Subarea 5) and they have the highest vertebral counts in the whole area.

(7) **Offshore Nova Scotia**—Resident populations of haddock with rapid growth and high vertebral counts are found offshore. During winter months these fish are joined by haddock from inshore Nova Scotia and the southern Gulf of St. Lawrence; the vertebral count appears to be somewhat higher at this season. The 1943, 1944, 1946 and 1947 year-classes have all contributed significantly to the landings from offshore banks during recent years.

There are, then, many populations of haddock in Subarea 4. The haddock populations off western Nova Scotia differ from those found offshore and around eastern Nova Scotia by migrating less extensively, by growing more slowly, by weighing more for a given length, by showing differences in the relative importance of year-classes and by having a lower vertebral count. The haddock populations of eastern Nova Scotia migrate seasonally, apparently to avoid the particularly low water temperatures which appear in this area during winter months.

Redfish

Redfish landings from Subarea 4 were small before 1945 but annual catches as high as 170 million pounds (77,000 metric tons) have been taken during recent years by United States trawlers. The Canadian catch is negligible.

The redfish of Subarea 4 differ from those of adjacent subareas in growth, meristic counts and parasitization. The absence of the external parasite *Sphyrion lumpi* is a striking characteristic of Subarea 4 redfish.

Within Subarea 4 there are many isolated deep water populations differing one from the other. Heavily exploited populations of small redfish are found off western Nova Scotia, central Nova Scotia and Cape Breton. Populations of large redfish have been found in deep water along the outer edge of Nova Scotian offshore banks and along the Laurentian Channel as far as Gaspé. Redfish appear to concentrate in tongues of deep water between the banks.

There are many gaps in our knowledge of redfish populations in Subarea 4—their size and extent, their diurnal and seasonal movements and their life history. The validity of age reading is not well established and population dynamics are therefore not understood. Further investigations of these problems are required before it will be possible to describe Subarea 4 redfish stocks in greater detail.

Halibut

Annual halibut landings from Subarea 4 average about four million pounds (2,000 metric tons) and most of the catch is taken in deep water off Nova Scotia. Catches are made close to shore off southwestern Nova Scotia and Anticosti but more are taken along the outer edge of offshore banks. Most of the Subarea 4 halibut catch is landed in Canada. The halibut populations of Subarea 4 do not cross the Fundian and Laurentian Channels; they are distinct from the halibut of other subareas.

Within Subarea 4 investigations have shown a number of halibut populations, none of which move very extensively. There are seasonal movements, apparently related to changes in bottom temperature; halibut move inshore coincident with the warming of bottom waters.

The halibut found off southwestern Nova Scotia differ from those of the northern Gulf of St. Lawrence in colouration, in size-and-age-composition and in growth. They have white or cherry-tinged, rather than grey, bellies, they are smaller and younger fish, and they grow more rapidly. Tagging has shown that even within this area the Roseway-LaHave halibut do no-intermingle with those found to the west. German Bank halibut move east to the Cape Sable Island area in late summer and return west to deep water in winter where they spawn. There is a drift of some halibut to eastern grounds but no movement to the west.

The halibut of the Anticosti region of the Gulf of St. Lawrence are old, slow-growing greys. Tagging has shown very limited movement along the Laurentian Channel with none re-captured west of this Channel.

Summary

(1) All four of the important groundfish species of Subarea 4 (cod, haddock, redfish and

halibut) are, for management purposes, distinct from the stocks of adjacent subareas.

(2) Within each species we find a number of discrete stocks in Subarea 4.

(3) Groundfish are taken both outside and inside the three-mile territorial limit and in each species we find that some populations are fished both offshore and inshore as they migrate from one area to another. Halibut move inshore at Cape Sable Island; cod and haddock move inshore at Cape Breton in spring and autumn months; and redfish may be taken close to shore off Digby Neck, Cape Breton and Gaspé.

(4) Bottom-living haddock and halibut stocks are more sharply divided by deep water channels than the more pelagic cod and redfish.

(5) Haddock and halibut are sensitive to very cold water. They move into shoal water during summer months and leave again before winter. They show more clearly defined migrations than the colder-water cod.

II. Knowledge of Divisions of Stocks of Cod, Haddock, Redfish and American Plaice in Subareas 3 and 2 of the Northwest Atlantic Convention Area

BY WILFRED TEMPLEMAN

COD

The cod provides the most important fishery in Subareas 2 and 3, considerably more important than the sum of all other fisheries both inshore and offshore. The international nature of the fishery in this area is mostly due to the large supplies of cod. Information on continuity or divisions of the cod stocks in these subareas has been obtained from average vertebral numbers, growth rates, studies of sexual maturity, from the distribution of parasites such as the cod-nematode *Porrocaecum* and the copepod *Lernaeocera*, and also from tagging. In the following account it will be necessary to discuss the west coast of Newfoundland part of Subarea 4 also since at the northern and southern ends of this area there are cod migrations between areas 3 and 4. Subareas 2 and 3 and the west coast of Newfoundland part of Subarea 4 have been referred to in this paper as the Labrador-Newfoundland fishing area.

Vertebral Studies. Over twelve thousand vertebral columns from more than 130 different samples well scattered over the Labrador-Newfoundland fishing area have been studied. The averages of vertebral numbers (not including the hypural) in the Newfoundland area are over 54 inshore and offshore along the east coast of Newfoundland to the northern edge of the Grand Bank and along the coast of Labrador. The vertebral average drops to usually below 53 on the central and southern part of the Grand Bank and on the southern half of the west coast of Newfoundland with intermediate values elsewhere.

Vertebral averages of cod in the Labrador area inshore and offshore, the Newfoundland east coast inshore and offshore, and on the northern edge of the Grand Bank are not statistically different so that the population could be the same. As we shall see later, however, from other evidence there are differences between various parts of this stock which show that while some mixing occurs it is very incomplete. Vertebral averages, on the other hand, show this northern stock to be distinct from that occupying the body of the Grand Bank generally and particularly from the cod stock on the southern part of the Grand Bank. It is most likely that the barrier between these two stocks is the layer of below zero water that surrounds at intermediate depths the western, northern and eastern edges of the Grand Bank.

Vertebral averages show a fairly distinct stock of cod along the southern half of the Newfoundland west coast. Gradually declining vertebral averages from the Strait of Belle Isle inward along the northern part of the Newfoundland west coast indicate an apparently seasonal extension of the east coast population into the northern part of the Gulf of St. Lawrence providing good fisheries in the Belle Isle Strait area. The cod stocks of the Labrador area, Subarea 2, are distinct from those of west Greenland, having considerably higher vertebral averages.

Growth Rates. The slow-growing Labrador cod show distinct differences in growth rate from the Newfoundland east coast cod which grow somewhat faster. The growth rate of the cod on the north and north-eastern part of the Grand Bank is still more rapid. The cod on the south and south-western part of the Grand Bank are by far the fastest growing in the whole Labrador-Newfoundland area. Thus from growth studies it is seen that the Labrador-Newfoundland east coast and northern edge of the Grand Bank cod which show no readily recognizable differences in vertebral averages are yet distinct enough to show considerably different growth rates. Hence the stocks cannot be very greatly intermingled.

Sexual Maturities. The size at first sexual maturity in the cod of the Labrador area appears to be small, that on the east coast of Newfoundland and on the northern and western

edges of the Grand Bank intermediate, and that on the southern part of the Grand Bank is by far the largest of all. Age of cod at first sexual maturity does not show such great differences as does size.

Incidence of the cod-nematode Porrocaecum in cod flesh. The incidence of the nematode parasite *Porrocaecum* has been studied in the fillets of over ten thousand cod. The parasite appears to have a long living period in the flesh and even the dead parasites can be recognized since the cuticle remains. Infection with this parasite is at its highest point, from 25 to 50 per cent of the fish infected, on the southern half of the west coast of Newfoundland and on the western half of the south coast. This population is shown to be somewhat distinct also by vertebral number and by tagging.

On the east coast of Newfoundland infection is low, usually 1 to 5 per cent of the fish. Infection of the Grand Bank is typically low mostly 1 to 3 per cent of the fish. On St. Pierre Bank infection on the northern part which is near a grey-seal colony is high—about 20 per cent, while on the southern part it is lower, about 4 per cent infection. Thus even on an area as small as St. Pierre Bank the northern and southern populations of cod apparently show considerable distinctness. The cod of the southern part of St. Pierre Bank with about 4 per cent infection show considerable distinctness from those of the neighbouring Banquereau with over 20 per cent infection.

Incidence of the cod copepod parasite Lernaeocera. The incidence of this parasite has also been studied in over ten thousand cod well distributed over the Newfoundland-Labrador area.

High infestation with *Lernaeocera* is characteristic of the inshore areas. The life of the parasite appears to be moderately long and even after the parasite has disappeared, the head with the neck stalk protruding can be found at the apex of the gills. It is a parasite very suitable for studies of the relationship of inshore and offshore cod populations. Infestation is low in Labrador mostly 0 to 3 per cent of the fish and moderately high in the coastal areas of Newfoundland ranging from 1 to 28 per cent and averaging between 5 and 10 per cent of the fish infected. The central, north-east, east, south and south-west parts of the Grand Bank have a very low infestation on the average considerably less than 0.5 per cent and usually zero infection in a sample of over a hundred fish. On the northwestern edge of the Grand Bank, however, infection is high, many samples showing over 5 per cent of the cod infected with *Lernaeocera*. This is in agreement with rates of infection several times as high in the neighbouring coastal cod of the Avalon Peninsula and indicates relationship between the coastal stocks of the extreme south-east Newfoundland area and those of the western edge of the Grand Bank. This relationship has been shown also by recaptures of tagged fish.

Tagging. About sixteen thousand cod have been tagged in the Labrador-Newfoundland area—eight thousand since 1947. The percentage returns from the inshore tagging are, with the best varieties of tags, thirty per cent or higher while returns from tagging on the Grand Bank are usually considerably less than five per cent.

Tag returns have shown considerable individual movement along the east coast of Newfoundland and some movement southward from Labrador to the east coast. In a great part of this area there is deep warmer Atlantic water close to the coast and the fish can apparently move considerably in this layer over winter. Tagging returns also show considerable autumn and winter movement of cod from the southern part of the east coast to the western and north-western edge of the Grand Bank for spawning, followed by an onshore movement of these fish with the capelin in June. In the same way that the vertebral numbers show a barrier to exist at the northern edge of the Grand Bank between high vertebral count northern and low vertebral count southern cod stocks so it is that cod from inshore tagging on the southern part of the east coast of Newfoundland are often returned from the northern and north-western edges of the bank but no recaptures are obtained on the south-eastern part of the bank. Similarily from tagging on the north-western edge of the Grand Bank there is a high percentage of recaptures inshore along the Avalon Peninsula and further

north while from tagging on the southern part of the Grand Bank there are few inshore recaptures, none along the east coast, and a few along the south coast of the island.

Tagging at Bay of Islands on the west coast of Newfoundland has shown a stock of cod which migrates southward out of the Gulf in the early winter to the Rose Blanche Bank area, not beyond Burgeo Bank and Hermitage, providing a good winter fishery on the western part of the south coast of Newfoundland, a return migration to the southern half of the west coast taking place again in late spring. Tag returns also indicate a movement of east coast cod into the Gulf of St. Lawrence through the Strait of Belle Isle. To judge by the fishery this movement is inward in June and out in the autumn.

Tagging on St. Pierre Bank has shown a fairly widespread movement of fish from this bank mostly to the south coast of Newfoundland, some to the Grand Bank and two across the Laurentian Channel to Banquereau. Apart from fish tagged on St. Pierre Bank it is very unusual for any fish tagged in Newfoundland to cross the Laurentian Channel to the Nova Scotia banks or to the southern side of the Gulf of St. Lawrence.

HADDOCK

In the Newfoundland area haddock are found in abundance only on the southern part of the Grand Bank and on St. Pierre Bank. There is some coastward movement of the mature and large immature fish during the summer time. There is another small population on the western part of the south coast and on the southern part of the west coast of Newfoundland. A few haddock apparently of still a fourth stock occur on the Flemish Cap. Studies of growth, year-class abundance and vertebral number have been been made and tagging experiments have been carried out.

Vertebral Numbers. Vertebral studies have shown no distinction between Grand Bank and St. Pierre Bank haddock. The haddock of the south-western angle of the coast of Newfoundland, on the basis of several samples only, have vertebral numbers lower than those of the two bank stocks and hence may be distinct from them. This stock is, however, of little importance. The possession of lower vertebral numbers by the Newfoundland haddock stocks show that they are distinct from the Banquereau stocks across the Laurentian Channel.

Tagging. Tagging of about a thousand otter-trawl-caught haddock on the Grand Bank has given no returns. A small amount of inshore tagging near Burin of trap-caught haddock gave several recaptures, one from St. Pierre Bank.

Growth Rates and Year-Classes. Growth rate studies and the maintenance over a considerable number of years of year-class differences show that the Grand Bank and the St. Pierre Bank haddock are relatively distinct. There appears to be some intermingling south of Green Bank and the few very large haddock caught on the Grand Bank where growth is slow appear to be of the St. Pierre Bank type. On the Grand Bank itself there is apparently considerable intermingling of stocks and no considerable differences exist between the stocks on the different parts of the bank.

A very small stock of haddock with a distinctly different growth rate pattern exists on the Flemish Cap.

REDFISH

(*Sebastes marinus*)

Evidence for distribution of stocks of redfish has mainly come from two sources, vertebral numbers and distribution of the redfish copepod parasite *Sphyrion lumpi*. Over eight thousand vertebral columns have been studied from Cape Chidley to George's Bank.

Vertebral Numbers. The northern stocks from Labrador-Newfoundland and from the Gulf of St. Lawrence generally have vertebral counts higher than those of the Nova Scotian shelf area and the vertebral number is slightly lower still in the Gulf of Maine. Even in the northern areas, however, redfish with very low vertebral averages will often be found quite near redfish populations with very high vertebral averages indicating either very little movement of redfish or considerable differences between vertebral numbers in different year-classes.

Distribution of Sphyrion lumpi. For many years it has been known that a heavy infection of redfish with the copepod parasite *Sphyrion lumpi* existed in the Gulf of Maine. Another centre of heavy infection by the parasite has been found in the redfish populations of Labrador while a minor centre exists on the eastern edge of the Grand Bank. Very low infestation by *Sphyrion* is found on the western part of the Grand Bank and in the Gulf of St. Lawrence and the parasite is apparently absent in the eastern Nova Scotia area. The external body of the individual *Sphyrion* parasite while certainly lost in time, would appear to have an existence long enough for it to act as a tag. Also the head remains embedded for a long time or indefinitely after the death of the parasite and by candling the fillets a very useful check on *Sphyrion* infestation can be obtained. The fact that high infestation can exist in populations of redfish while within a very short distance other populations show very low or no infestation is an indication that redfish do not migrate freely over large areas.

Age and Growth and Maturity Differences. These are being studied. There are differences in various areas in sizes at maturity and growth differences undoubtedly exist but age reading of redfish otoliths is not yet on a completely firm foundation.

AMERICAN PLAICE

(*Hippoglossoides platessoides*)

Vertebral and fin-ray averages from large numbers of American plaice have shown no statistical differences within areas 2 and 3. Maturity and size differences exist which allow some differentiation of stocks. The American plaice of the large population commercially fished on the eastern side of the Grand Bank mature at a considerably larger size and grow much larger than inshore plaice. Age studies have been begun but because of the small otoliths and the great age (20-40 years) of commercial plaice accurate and reproducible age readings are difficult to obtain.

SUMMARY

Cod. Three well marked divisions of the cod stock in the Labrador-Newfoundland area have been shown by vertebral counts and tagging returns—the Newfoundland southern west coast and western south coast stock, the Labrador, east coast Newfoundland and northern edge Grand Bank stock, and the southern and central Grand Bank stock. These three stocks, the latter two of major importance, are well separated by migratory and vertebral patterns, and migration between them is hindered by natural barriers apparently mainly bottom temperature barriers. Growth rate studies show enough distinctions within these stocks to indicate that complete intermingling within a stock does not occur. This is well illustrated in the considerable growth differences between the Labrador, Newfoundland east coast and northern Grand Bank sections of the northern stock. Within a stock, however, the lack of intermingling is due more to distance than to a temperature or depth barrier.

Tagging and *Porrocaecum* and *Lernaeocera* infestation show the relation of the cod of the western edge of the Grand Bank and those of the southern part of the east coast of Newfoundland and the lack of relation of cod in this area to the southern Grand Bank cod populations. The inter-relationships of the St. Pierre Bank, south coast, and southern Grand Bank areas are complex. Some intermingling is shown and further study is needed. There is considerable intermigration between St. Pierre Bank and the south coast cod stocks. The deep warm water of the Laurentian Channel is to a considerable degree a barrier to southward movement of the Newfoundland stocks of cod. In the north the cod stocks of the Labrador area, Subarea 2, are shown by highly different vertebral averages and lack of any considerable intermigration of tagged fish to be distinct from those of west Greenland.

Haddock. There are two large haddock stocks, the Grand Bank and the St. Pierre Bank stocks, with a minor stock at the southwestern corner of the island and very minor stock on the Flemish Cap. The Newfoundland haddock populations are separated from those of the Nova Scotian Banks judging by average vertebral numbers, and the St. Pierre Bank and the Grand Bank stocks are shown to be relatively distinct by differing growth rates and differences in year-

class abundance continuing for a considerable number of years following occasional differences in year-class survival.

Redfish. Vertebral numbers decrease gradually from north to south and the discontinuous distribution of the redfish parasite *Sphyrion lumpi* with populations of high infection close to those with low infection indicates lack of large-scale long-distance migration in this species.

American Plaice. The stock fished commercially on the eastern edge of the Grand Bank can be distinguished from the inshore stocks by larger size at sexual maturity and larger final size. Average vertebral numbers and fin-ray counts do not show distinct differences in plaice populations within Subareas 2 and 3.

PART 5

Contributions to a Special Meeting on Long-Term Hydrographic Changes and their Effects on Fish Stocks in the Northwest Atlantic Area

I. Introductory Remarks

BY DR. J. L. KASK, CHAIRMAN OF THE COMMISSION

Ladies and Gentlemen:

Most of us are well aware that the world's climate has undergone frequent and sometimes violent changes during its history. We, however, usually associate such changes with long periods of time. I do not think for instance that any of us are much concerned about being personally overtaken by a new ice age in our time. But most of us are not aware that very gradual but significant changes in climate have taken place in our lifetime. Changes significant enough to influence the whole regime of life in the ocean, of sufficient significance for instance to cause great changes in the abundance and distribution of some important food fishes, which have had important consequences on the fishing industry for good and for bad. There are other evidences of this change too as we have heard recently from those loyal citizens of Halifax that have offered facilities in that lovely city for ICNAF headquarters. They strongly protest and can document that the climate in Halifax has become progressively warmer and more pleasant during the past fifty years. All of these changes are of the greatest import to those of us that are associated with the work and the aims of ICNAF.

Our conference documents Nos. 24, 25 and 26 deal with this subject of Climatic Changes. Those of us that have had the opportunity to read these important contributions already have some idea of what this panel plans to discuss here tonight. Of the five authors that have contributed to these observations, three are here present, and are prepared to review the material in the prepared papers and to answer any questions which may occur to the members of the audience.

I have not been given any advice as to the order in which the panel participants are to appear, so I will follow the usual international practice of calling on the speakers in the alphabetical order of the country from which he comes. If this is agreeable, then I will call on Dr. W. Templeman of Canada first. Dr. Templeman is Director of the Fisheries Research Station of the Fisheries Research Board of Canada at St. John's, Newfoundland. Situated as he is almost on the great fishing banks of the Northwest Atlantic, his observations should prove of unusual interest. Following Dr. Templeman will appear the distinguished marine biologist, Dr. Å. Vedel Tåning of Denmark, and following Dr. Tåning, we will have Dr. Herbert Graham, Director of the Woods Hole Fisheries Research Station of the United States Fish and Wildlife Service.

Because of the lateness of the hour and the length of the program, I will ask the speakers to appear in the order suggested without further introduction or comment. I would ask members of the audience to ask any questions as they occur to them during the discussion, so that we may proceed with dispatch.

I will first call on Dr. W. Templeman to lead off with tonight's discussion.

II. Changes in the Distribution of Marine Animals in New England and Middle Atlantic Waters in Relation to Changes in Temperature

BY CLYDE C. TAYLOR AND HERBERT W. GRAHAM

Author's Abstract [1]

Air temperature records at New Haven, Conn. since 1780 and at Eastport, Maine since 1874 show pronounced upward trends since about 1885, the increases being most marked for winter months. Similar trends in sea surface temperatures are shown for records kept at Woods Hole since 1881 (incomplete), Boothbay Harbor, Maine, since 1906, and St. Andrews, New Brunswick, since 1921.

The possible influence of these temperature changes on the distribution and abundance of marine species is discussed. Mackerel catches appear to be related to air temperature fluctuations for data extending over a period of 130 years. Landings of both lobsters and whiting (*Merluccius bilinearis*) suggest the decline in catches south of Cape Cod may be due to the warming of inshore waters, while north of Cape Cod the warming has produced optimal conditions resulting in greatly increased catches of both species since 1940. Commercial catches of whiting indicate that this species now winters in the Gulf of Maine whereas formerly it was a summer species. Menhaden, which had not been fished in Maine waters since the end of the 19th century, reappeared in 1945 and have become commercially exploited. Records of southern species north of Cape Cod have been published with increasing frequency since 1940, including the king mackerel, frigate mackerel, little tuna, filefish and dolphin. The range of the green crab has extended northward from Cape Cod in 1874 to Passamaquoddy Bay at present. Prior to 1930 the average of January-February surface temperatures at Boothbay Harbor was 30.3°F. For the period 1930-1949 it was 34.2°F. and from 1945-1949 it was 35.1°F. It is suggested that this amelioration of winter conditions has enabled this crab to establish permanent populations within its new northern range.

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[1] The paper is being published in U.S. Department of Interior, Fish and Wildlife Service, Fishery Bulletin, No. XX, Vol. XX

III. Long Term Changes in Hydrography and Fluctuations in Fish Stocks

BY Å. VEDEL TÅNING

Climatic changes have for a number of years been variously manifested all over the world. Such changes have particularly been observed since the middle of the nineteen-twenties especially in the arctic and the sub-arctic, but also in the temperate areas in and around the North Atlantic ocean. Owing to the influence of these changes on the fluctuations in certain very important fish stocks, they present the most important general problem of present day fishery investigations in the said oceanic areas.

The main question in fishery research and in fishery itself is whether the change in the marine climate as observed in our times will persist over a long period, or whether it has already passed its peak, to the effect that the conditions more or less ruling for a century or more and therefore regarded as normal are returning. With relation to this one significant point should be given due consideration. Whereas the present warm period evidently is a secular, long-term phenomenon, it is important to note that much shorter, irregular variations in temperature occur for only a few years or even for a certain season of a year only. These short-term variations may show much larger amplitudes than long-term variations, and may therefore temporarily in much greater measure affect, for instance, the production of one or more year-classes of cod, and therefore in due time to a very high degree the yield of the fishery. The difference between these irregular changes and the long-term changes is the persistence of the latter during a long series of years.

With a view to setting up a program for research on the correlation between variations in the marine environment and the long-term fluctuations in the stocks of the commercially more important species of fish in the North Atlantic, it would be appropriate to consider the following questions:—

1. What recent changes in the stocks, as regards size of stock, migration, etc., may be solely due to long-term climatic changes?
2. What coinciding hydrographic conditions may be considered the direct cause of the changes in the stocks?
3. Are there any earlier records available from the last hundred and fifty years of similar changes in fish stocks and hydrographic conditions which yield some information on the duration and frequency of such changes?
4. What biological and hydrographic observations afford the possibility of forecasting future good or bad secular periods in the fishery?

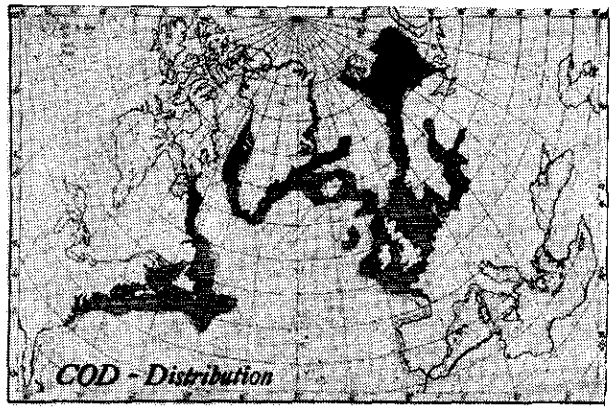

Fig. 1. Rough sketch of distribution of cod in the North Atlantic. Double hatching indicates areas where density of cod approximately has increased in recent time.

The northward shift and the simultaneous increase over a series of years of the magnitude of the stocks of commercially important species of fish constitute a surer proof of a climatic improvement than many of the isolated records of rare exotic fishes or other marine animals. For economic reasons fishery has in fact always had an open eye for a rising stock of commercially useful fish in border areas, and during the past few generations, at least, fishermen have been ready to extend the fishery into the northern areas, when the stocks make an appearance there, and to make the best use of any increase. Fishery statistics accordingly yield excellent information upon this subject in spite of obvious deficiencies, particularly in earlier times.

However, the northward dispersion of several southerly species is in many instances most noticeable and the phenomenon well established. Consequently many data of great value have been recorded during this past generation, proving that faunistic information on the appearance of rare exotic animals may be very valuable.

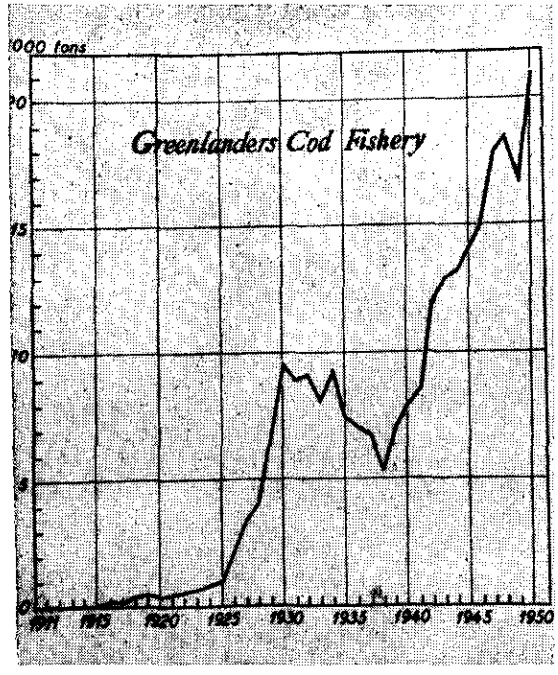

Fig. 2 Landings of cod by Greenlanders 1911-1950 (fresh, round fish in 1000 tons).

We may mention here, in brief, a few examples taken from the practical fishery to show certain changes that have occurred among commercially important species of fish. The cod is the classical example. The increase in the stock of cod at Greenland in present times is a wellknown fact. The annual yield, for a few years just before 1920, amounted only to approximately 350 tons per year (caught by Greenlanders alone), whereas the catch in 1951 amounted to 168,650 tons (of which about 18,000 tons were caught by Greenlanders). Furthermore, the area of the cod fishery at West Greenland has gradually expanded farther northwards following the progress of the stock. Now, moreover, the cod largely propagates in Greenland waters, avoiding the previously recorded migration to the Icelandic spawning grounds. On the eastern side of the Atlantic Ocean the cod fishery has also been extended northwards, indicating an expansion of the stocks. Thus, while the catch per hour of British trawlers in the Barents Sea in the period of 1924-1928 yearly averaged 16.5 tons, the corresponding average for the period of 1947-1951 was 72.6 tons. In the Baltic the cod fishery also increased enormously, more so in the last half of the 'thirties; and in this area a total of 10 million kilos was caught by fishermen of all nations in 1935, while in 1949 the total catch was 65 million kilos. Also other economically important species of fish have appeared in increasing number in northern waters; and so a corresponding extension of fishery has occurred. Thus, from the northeastern area (the Barents Sea, etc.) haddock and redfish may be mentioned; at Norway, in the Baltic Sea, and at Greenland, an increase in the stock of herring; and in the North Sea an increase in the stock of sole (the Danish fishery increased from about 200 tons in the 'twenties to about 3,000 tons in 1951). The fact that certain overfished stocks decreased in certain waters at the same time on account of the increasing fishing intensity makes no difference to the above observations.

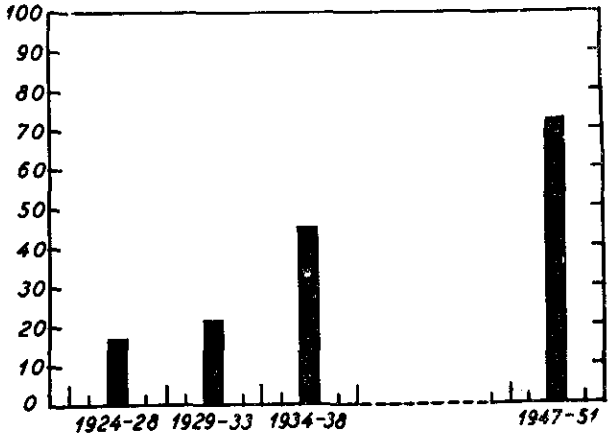

Fig. 3. Catch of cod in tons per 100 hrs. trawling by British steam trawlers in the Barents Sea. 5-years averages 1924-1951.

Next, if we consider purely faunistic records made during these past 30-40 years, relating to the northern parts of the Atlantic Ocean and areas adjacent thereto, changes in the fauna are evident. It must not be overlooked, however, that opportunities for observations on the rarer species, especially in the northern areas, have

been augmented with the increasing navigation in these waters and with the easier access to publication of faunistic observations. Even so, the facts are so numerous that they clearly indicate that southern species have made their way far to the north, while northern (arctic and subarctic) species have lost ground at their southern limits and have been forced to retreat further northwards. The conditions have been explored prin-

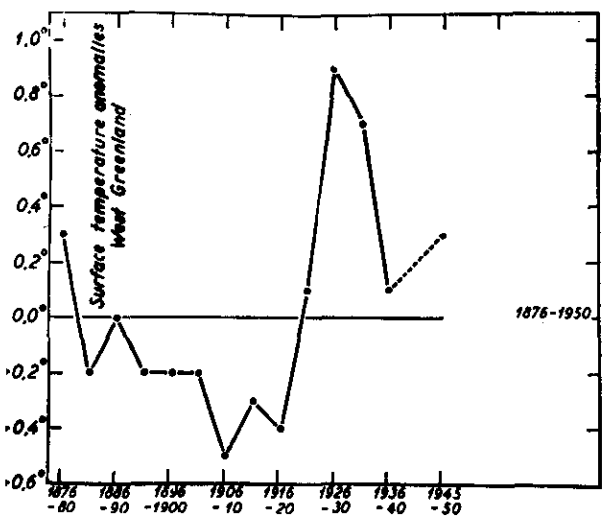

Fig. 4. 5-years averages of the surface temperature anomalies. West-Greenland 1876-1950 (after F. Hermann 1953).

cipally at Greenland (by Ad. Jensen and Paul M. Hansen), at Iceland (by B. Sæmundsson and Arni Fridriksson), and at Norway (by S. Johnson). Certain species are so distinctive or of such size, e.g., the Basking Shark (*Cetorhinus*), that if they had been there formerly, it would have been noticed. Thus the presence of this giant which has been observed e.g. at East Iceland, at West Greenland, and in Danish waters as far as the western Baltic Sea in our time, but not in the previous 150-200 years, must be regarded as certain evidence of a great change. Furthermore, when at the same time the hydrographic observations indicate that the conditions in the invaded areas have come close to the requirements of the said species with regard to the temperature and salinity, the contributory causes seem to be obvious. Many other similar examples may be mentioned: the occurrence south of Iceland of the *Velella*, the *Caranx* in great quantity at Iceland and the Faroe Islands, and, for the first time, the *Alosa finta*, the *Xiphias*, the *Gadus pollachius*, and others, at Iceland, etc. On the other hand, the decline in arctic species should be noted, e.g.; the retreat of the White Whale (*Delphinapterus*), and the Greenland Shark (*Somniosus*) and also other species from certain of the southern areas of West Greenland.

However, the rising temperature has not only affected the distribution, spawning places etc. of the stocks. The influence is noticeable also in the morphology of the fishes. Thus, in various populations of fish the so-called "racial characters" have undergone a change during the past generation; e.g. in certain varieties of herring, which on account of the rise in temperature now possess a lower average number of vertebrae compared with thirty years ago. This phenotypical change, naturally, will change back to the normal state when the environment again becomes normal; and perhaps in the future this phenomenon may be used as an indicator to changes occurring in the sea.

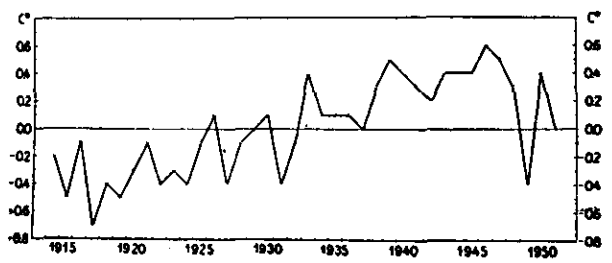

Fig. 5. Yearly averages of the monthly anomalies of the surface temperature at Myggenæs, FAROES, 1914-1950 (after J. Smed 1952).

As is well known, the changes which have taken place in the ecological conditions coincide with rather great changes in the hydrography of the North Atlantic Ocean. When in the considered period the average air temperature at Spitzbergen in the winter has risen about 10°C., and approximately the same at Jacobshavn in North Greenland, the temperature of the sea has increased by 0.5°C. to about 3°C.; this rise is observed mainly in the northern regions, but also southwards to the sources of the Gulf Stream; and the increase is not only observed at the surface but also in some areas at depths down to

600-800 m. At the same time, the arctic ice has decreased in thickness, and its front in the ocean has retreated far to the north. This is particularly the case in the Barents Sea and to

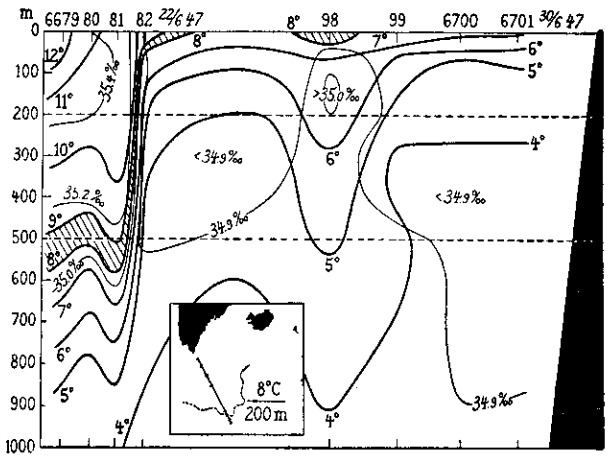

Fig. 6. Hydrographic section across the northern border of the Gulf Stream from about 49° N. Lat. 31° W. Long. to Cape Farewell, Greenland ("Dana" 1947). The inset shows the position of the section and the 8°C curve at a depth of 200 meters. (After Tåning 1949).

the east thereof, at Spitzbergen and at Greenland, where the eastern coast was free of ice south from Angmagssalik during the latter part of certain summers in the 'thirties.

In this connection the wellknown fact should be stressed that almost the entire masses of Atlantic water which reach West Greenland (and for that matter, the arctic regions of the Atlantic Ocean on the whole) pass northwards between Ireland and a position somewhere about 100 n.m WSW of Ireland at Lat. 50°N., Long. 30°W. This is the water carrying the increased warmth to the fishing banks of West Greenland, thus causing the rich fishery of recent times. It would therefore seem ideal to commence continuous hydrographic researches in this area, besides at the fishing banks north of Lat. 50°N, with the aim to keep under observation the annual and the long term variations occurring in the current of warm water supplied through this ocean gate.

However, here is not the place for details on the hydrographic changes in the North Atlantic Ocean, as such may be widely found in recent hydrographic reports from this area. Up till now we have only slight knowledge of the influence on biological changes caused by hydrographic factors other than those of temperature, salinity, and such nutrient salts as phosphates and nitrates.

Nor is here the place for details on the various instances of the effect of climatic marine changes observed far into smaller waters neighbouring the North Atlantic Ocean. However, also in such adjacent waters considerable and striking effects may be observed. With the increased circulation

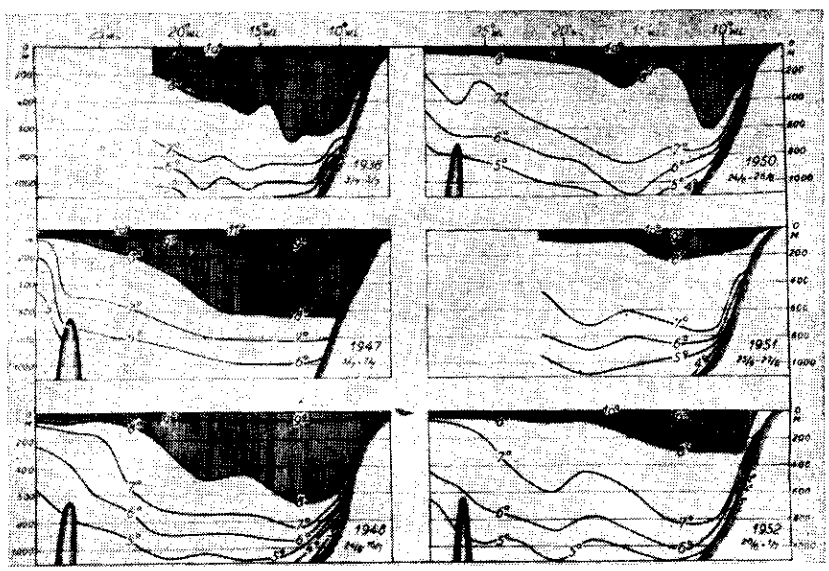

Fig. 7. Hydrographic sections of the deep water between the Faroes and East Greenland showing recent trend in temperatures (about 1st July); area with temperatures above 8°C is hatched.

of the Atlantic waters, no doubt caused by an increase in the atmospheric circulation, salter and warmer waters rounding the British Isles to the north have passed into the North Sea, and from there through the Danish waters into the Baltic Sea. E. Goedecke (1952) has observed

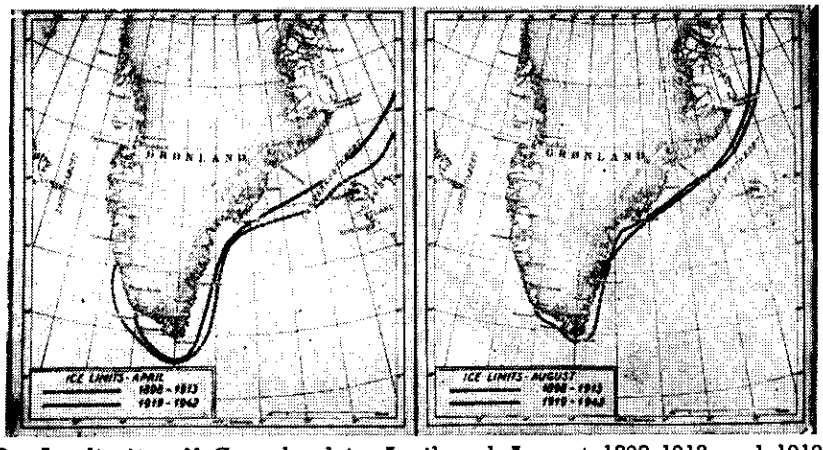

Fig. 8. Ice limits off Greenland in April and August 1898-1913 and 1919-1942. (After F. Hermann 1953).

a rise in temperature of about 0.3°C. to 1°C. in the North Sea, principally in the summer and autumn seasons of 1931-1950 compared with 1901-1930. For the southeastern part of the North Sea this phenomenon is in some measure due to the simultaneous temperature rise on the neighbouring continent.

It is reasonable to assume that the arctic ice conditions, on broad lines, may be taken as fairly significant indicators of warm or cold periods in the North Atlantic Region. At any rate, we have hardly any other reliable facts from earlier times on the oceanic hydrographical conditions than the information gained from the forward and backward movements of the ice front. Only with the hydrographic observations of modern times a more reliable foothold has been obtained. Very scattered hydrographic observations exist namely from the first 75 years of the nineteenth century obtained *inter alia*, from expeditions having entirely different purpose than oceanographic exploration. Consequently, where the problem is the study of changes in the environments in earlier times, there are not many facts to rely on. Surface temperatures recorded since the time when such data on the conditions in the northern seas were more systematically collected, may yield some information. According to Jens Smed, among others, there is evidence from several parts of the North Atlantic Ocean that somewhat warmer conditions existed about the period of 1875--1883, and that the present rise in temperature did not properly com-

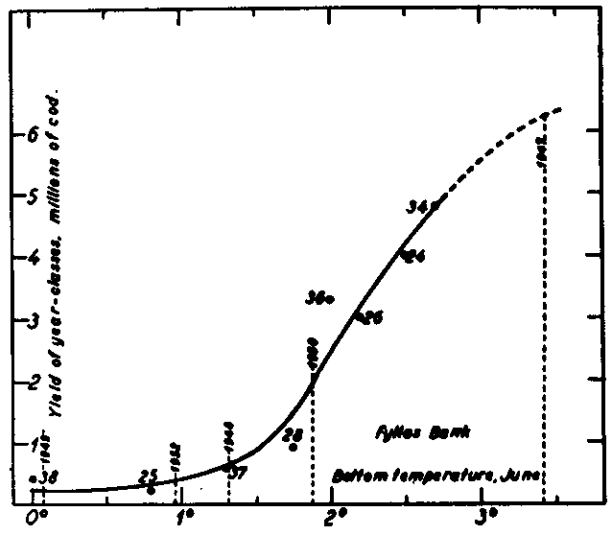

Fig. 9. Correlation between bottom temperature in June on Fyllas Bank, off West-Greenland, and the subsequent yield of the various year-classes of cod in Greenland waters. High temperatures produce rich year-classes of cod. 36 year-class 1936 etc. (After F. Hermann 1953).

mence until about 1917-1922, and more markedly after 1925. These, and many other observations (mentioned by Scherhag, Slocum, Sverdrup, H. Thomsen, a.o.), plainly show a rise in temperature in the ocean in recent times coincidental with

changes in the stocks of fish and invasions into the northern waters of numerous southerly marine animals. However, the facts from this period are wellknown and require no further elaboration.

For practical reasons it is considered convenient here to summarize the physico-chemical factors which during the present climatic fluctuations have evidently most contributed to changes in the size of the fish stocks, in their migrations, etc., and to render a brief account of their direct ecological effects. Thereby it may be possible to decide on the fields in which future exploration in particular should be planned.

I. The rise in temperature in the sea has no doubt been of the utmost importance and may, in effect, have had the following results:—

a. The locality of the spawning places of the fish:

1. The intensity of spawning at the southern limit of the normal area of distribution of the species may have diminished or even have ceased entirely.

2. The intensity of spawning at the northern limit of the normal area of distribution of the species may have increased, or quite new spawning grounds to the north may have been invaded (e.g., as for cod at Greenland).

3. A rise in the temperature in the deep sea, as has been observed in northern waters down to a depth of no less than 200-600 m., may produce changes both in the locality of the spawning grounds and in the distribution of semi-oceanic or purely oceanic fish stocks, such as, e.g., the redfish.

b. Nursery and feeding grounds of very large northward extent have been opened by the rise in temperature (cfr. the dispersion of cod in the Spitzbergen-Bjorno area and in the Barents Sea, as also at West Greenland). This space factor, undoubtedly, has immensely affected the increase in the stock of cod and has caused changes, as well, in the migration and dispersion of the cod and other marine animals.

c. The increase in food brought about by the rise in temperature affords great opportunities for increased growth of young fish in the northern, now warmer areas, inasmuch as food in greater quantity over an extended area is of much greater benefit to the fish than a particularly heavy increase of food in a smaller, normal area. Increased spawning within the normal spawning area of a species and with normal dispersion possibilities brings about a numerous though slowgrowing year-class, whereas increased spawning from which the fry may spread over a nursery area much larger than the normal one, affords the year-class opportunities of extremely rapid development.

d. The growth period is prolonged especially in the northern regions by a rise in temperature, and this may further contribute to the improvement of a year-class.

e. The lethal threshold of tiny fish larvae is of particular importance to the stocks of fish in arctic-subarctic areas. For various species of fish a certain temperature limit exists, below which the tiny fry are unable to ingest food (probably their muscular activity is impeded) so that they die. For cod this limit seems to lie close to 1.8°C., and in the present warmer period in certain northern spawning areas, temperatures below this limit have not occurred so often as in the cold periods. For this reason several excellent year-classes have cropped up in areas which the cod previously did not use for permanent spawning grounds (e.g. at West Greenland).

II. Variations in the course, velocity and water transport of the oceanic currents are, in conjunction with the temperature factor, of extremely great importance. With a

more rapid transport of the water masses, in a favourable period, the fry and the young fish will be carried to new nursery areas with ample food earlier in the season than in a normal period. Thus an overpopulation of the area of dispersion in the vicinity of the spawning area early in the season will be avoided (cfr. the cod at West Greenland, Spitzbergen, and in the Barents Sea). With the quicker and more voluminous water transport many southern boreal and sub-tropical species have been carried far to the north, where they have displaced the more northern species.

III. It is probable that, with the increasing masses of Atlantic warm water, important nutrient salts, such as nitrates and phosphates, in greater quantity than formerly have entered the cycle of production of fish food in the northern seas and in inner waters, such as, e.g., the Baltic Sea.

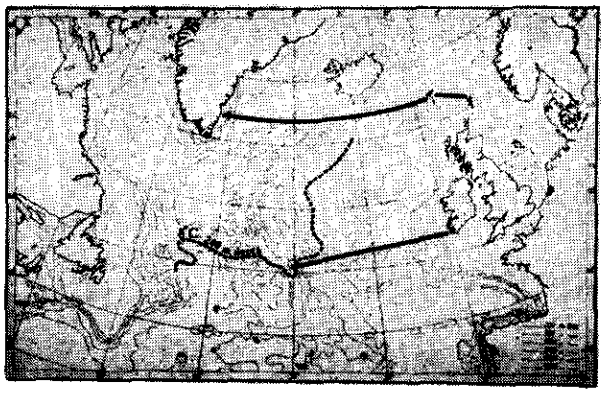

Fig. 10. Position of the proposed hydrographic section west of Ireland (cfr. fig. 6) and sections between Shetland and Faroe, and between Faroe and East-Greenland (cfr. fig. 7).

In order to bring light to bear on the present warm period the question of whether similar warm periods of importance to fishery are known from former times can be raised. This question, as is well known, can be answered in the affirmative. However, the first accounts of any value, with reference to important changes in fishery, derive from a period near the close of the nineteenth century and the time thereafter. Unfortunately, only from the eighteen-seventies have more detailed, simultaneous hydrographic observations been recorded, in fact almost only covering the last fifty years. It is from the arctic-subarctic areas, principally, that clear or fairly clear observations are available.

From the North Atlantic area (according to Ad. S. Jensen, a.o.) we have mainly records of the cod fishery, proving fluctuations in the occurrence of cod along the West Greenland coast. These records have been further added to in recent times by valuable observations from Norway-Spitzbergen. The warm periods thus accounted for have been of importance not only to the stocks of cod, but naturally also to other commercially valuable fish and to the marine fauna in general.

Some time in the period of 1810-1823, cod is said to have been particularly numerous at West Greenland, in the entire coastal region from Julianehåb to Disko Bay. There is various evidence to the fact that this period must have been mild in the North Atlantic Ocean; thus, some southern species of fish were observed at Iceland about that time.

The next period falls about 1845-1849, when catches of cod made by British fishing vessels were said to be good even so far north as the Disko Bay. There is no certainty whether this and the earlier mentioned period were results of temperature rises in the sea equal to the one prevailing now. These shorter warm periods were as far as we know less effective than the present one. During the first half of the nineteenth century (in particular about 1840-1854), the spread of ice at Greenland was less than during the last half of the century, when the presence of heavy masses of ice was the rule in most of the years. On the whole, the nineteenth century was richer in ice than this present century up to now.

We have no reports from the last half of the nineteenth century covering periods with striking occurrences of cod at West Greenland or other West Atlantic northern areas. American fishermen, however, found halibut on the banks in great quantity during 1866-1881, but cod, at any rate, was not abundant there (Scudder). Various observations of temperature, made in the Greenland area, indicate, however, that in the 'seventies and'eighties a somewhat warmer period actually prevailed (Kiilerich, Dunbar). And

from this period, more particularly in 1873-1882, the cod fishery in the East Atlantic area afforded rich catches at Spitzbergen. Also other known records of southern animals appearing about this time in the north prove that in the Atlantic Ocean at any rate, and perhaps particularly in the Northeast Atlantic, warm water in richer supply than the normal was present. It may be added that the Northeast passage was navigated for the first time during that period.

The period, especially in the years 1873-1884, is also known to have been warm in the southern part of the North Sea. Those years were followed by a period of lower temperatures, which changed again about the year 1915, and especially about the year 1931, into the present warm period (Goedecke 1952). In good agreement with the statements from the Spitzbergen fishery is the fact that the fishery at Lofoten (on spawning fish grown up in northern waters) during the period of 1865-1897, approximately, was a rich one. This again was followed by a poor period, until the present rich period began to show up, in particular since 1927. In the Spitzbergen area there was no cod fishery during the period 1883-1925, whereupon a rich fishery began again. It is not known, however, when exactly the cod again invaded the Spitzbergen area in the present century. The present favourable period began at West Greenland about the year 1917, when, as we know, a specially good year-class was born. An increase was particularly noticeable, however, from the year 1926, when the usually rich year-class of 1922 dominated in the catches of the Greenlanders.

Thus it seems evident that in the course of the previous century we had three rather short warm periods in the North Atlantic area; i.e., about 1810-1823, about 1840-1850, and about 1873-1882, and that the longer and warmer period of our present century, which from a meteorological point of view, perhaps, was traceable initially one and a half century ago, or more, first became noticeable about the year 1915, increased in the 'thirties—'forties, and now perhaps is on the wane. Important data on the chronology of the periods are available in scattered faunistic records (on fishes, birds, etc.) Very many records of southern indicator species in northern areas at Iceland, Norway, and Greenland, incidentally occur just in the periods stated.

It may be added here that in this century in particular after the year 1910, the ice masses at East Greenland, down south and round Cape Farewell to the west coast, have diminished so much that we have to look back largely to the period of 1400-1600 for evidence of similar conditions.

When the author, being a fishery biologist, now has to propose a long-term program for observing or, as the case may be, forecasting the periods of fluctuation in the great northern fisheries, more particularly in the cod fishery, he may suggest: that the hydrographic observations be so planned that changes in temperature, at any rate in the upper 500 m. of the open sea, should be kept under observation in the region where the Atlantic waters west of Ireland (between Ireland and a position about Lat. 50° N., Long 30°W.) flow northwards and disperse over the eastern and western areas of the North Atlantic Ocean. Such observations, it would appear, is the most essential part of a program aiming at exploring climatic changes in the North Atlantic Ocean. Also changes in the water masses to the north of Lat. 50° N. should be observed in sections across all important fishing banks; and, at the same time, changes in the important cold currents (the Labrador current, the East-Greenland current, and the East-Iceland polar current) should also be explored. Quarterly observations would probably be sufficient for this purpose, and it is considered that observations on temperature, salinity, contents of phosphates and nitrates, currents and ice conditions will be necessary. It would be very valuable if automatic registration of especially the temperature soon may be possible in the main currents of special interest to these studies.

By carrying on the fixed long term research programs of recent years, and by improving the fishery statistics, the fishery biological part of the program will, no doubt, be adequately covered. A close collaboration between ICNAF and ICES in both the hydrographic and the biological work is of course of paramount importance.

More than twenty years have passed since fishery biologists first realized that a warm period was evidently becoming a fact. However, whether this period, as some people think, is now petering out, or whether it will continue, cannot be known at the present time with any degree of certainty. At any rate, we have not in the past century and a half had a better opportunity for a closer study of the effect of a warm period on the distribution of the fish, their migrations, growth, etc. Even if we do not know whether we are now at the close of a warm period, or in the middle, or whether the warm period will continue into the distant future, it is evident that it may be of far-reaching importance to future exploration in this field, if we now endeavour to follow the course of events, both by comprehensive hydrographic observations and by observing the effects on the distribution, life history, etc. of fish and other marine animals. Much research is being done in the latter field, which can be applied to elucidate the influence of climatic changes. However, there seems to be lacking the co-ordinating forces in the hydrographic observations which may enable marine biologists to determine sooner or later the exact physico-chemical causes, both in the coastal areas and in the open northern Atlantic Ocean. As far as we know these causes have—by short term as well as long term changes— produced the observed fluctuations in the stocks of fish, changes in the course of migration, etc. These are matters of the greatest importance to fishery and detailed knowledge of them may in future to some extent make it possible for fishery biologists to predict changes in the great fisheries of the utmost value to the economy of the subarctic fisheries of several countries and to the fishery policy of these countries.

It would badly serve to repeat the deplorable error committed at the beginning of this century by the International Council for the Exploration of the Sea (ICES), when the scheme of quarterly sections of stations, which had been established over the North Atlantic Ocean for the very purpose of keeping watch on the changes was discontinued after a few years. Anyone who has been working in this area for many years, has no doubt often wished that this systematic work had been continued in one form or other. We should then have known considerably more than we do now, *inter alia*, about the causes of some of the great fluctuations in the fisheries.

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IV. Long Term Changes in Hydrographic Conditions and Corresponding Changes in the Abundance of Marine Animals

BY WILFRED TEMPLEMAN AND A. M. FLEMING

NEWFOUNDLAND FISHERIES RESEARCH STATION

INTRODUCTION

The following account of marine animal abundance and climatic variations has particular reference to Subareas 3 and 2 of ICNAF.

We are grateful to the Meteorological Station at the Torbay Airport for the use of air temperature data. Thanks are also due to Mr. Hubert Squires of the staff of the Newfoundland Station for the use of his squid abundance data and to Mr. R. P. Hunt for assistance in a survey of hydrographic data for Subareas 3 and 2 in an attempt to find valid comparisons.

SEA AND AIR TEMPERATURES

Sea Water Temperatures Subareas 3 and 2.

In Subareas 3 and 2 there are no seawater temperatures for long periods and in the same positions. The hydrographic records of the Newfoundland Fisheries Research Station date only from 1947 but since that date six sections across the Labrador current from southern Labrador to the southern extremity of the Grand Bank have been taken regularly at approximately the same time of the year, the southern ones twice a year in March—April and July—August and the northern in July—August only. Two sections northward as far as Cape Chidley are occupied more irregularly. The former Fisheries Research Station under Dr. Thompson at Bay Bulls, Newfoundland, obtained temperature records between 1931 and 1935 but not at the same time of year nor from the same stations as the more recent records.

The International Ice Patrol has a series of records for the same sections on the eastern edge of the Grand Bank for 8 years from 1934 to 1941 and from 1948 to the present. Further north a section across the Labrador Sea from South Wolf Island, Labrador, in Subarea 2 to Cape Farewell, Greenland, Subarea 1, has been occupied once during each of 15 summers between 1928 and 1952. Within this group of observations the longest unbroken stretch is the series of 5 years from 1948-52. The Ice Patrol has taken many other sections across the Labrador current in addition to the above but none were repeated for so many years.

In addition there are hydrographical observations in Subarea 3 by French research ships in occasional years, particularly since 1924. In recent years the Atlantic Oceanographic group at St. Andrews has made some summer and autumn cruises in Subarea 3. Canadian hydrographic ships have taken temperatures particularly in Subarea 2 and innumerable bathythermograph observations have been taken by U.S. and Canadian naval and other ships especially in Subarea 3.

Iselin in the schooner Chance carried out hydrographic observations in July—August, 1926, taking sections across the Labrador current in Subareas 2 and 3. During the Canadian Fisheries Expedition of 1914-15 under the direction of Dr. Hjort, hydrographic stations were occupied in 1915 in the southwestern part of Subarea 3 on St. Pierre Bank, Green Bank and in neighbouring channels. In 1913 the Scotia expedition under Dr. D. J. Matthews carried out the first systematic hydrographic study of the Grand Bank and Subarea 3 waters and in Subarea 2 at the level of Hamilton Inlet made a section across the Labrador current. In the summer of 1910 the "Michael Sars" Expedition made two sections of the Grand Bank area, one east to west over the northern part of the bank and one from St. John's southward across the bank. A more detailed review of these and other hydrographic observations in Subareas 2 and 3 is to be found in Smith, Soule and Mosby (1937) and Dunbar (1951).

There are many difficulties in making use of these data for a study of long-term changes in hydrographic conditions. It is noticeable at once that apart from very recent data there is too little agreement in the position of the stations from year to year for ready comparison to be made. Also, comparisons from isolated years are not of great importance in assessing long-term trends since temperatures in individual years may vary greatly during any period. Thus in the recent presumably warmer period, in Subareas 2 and 3 the year 1950 was characterised by a greater abundance of very low temperature water than any other year since 1928 for which good records exist.

From the hydrographic records of the Canadian Fisheries Expedition in the neighbourhood of St. Pierre and Green Banks in 1915 (Bjerkan, 1919) it is indicated that bottom temperatures on the average were lower in 1915 than in 1946-49 and in 1951-53.

Mr. Floyd Soule, Oceanographer with the Ice Patrol, in a private communication says that the part of the eastern branch of the Labrador current measured on the east side of the Grand Bank has been decidedly less since the war than it was during the period 1934-41.

It is indicated by our examination of the available data, in so far as former stations were near present stations, that no long-term temperature data suitable for comparison exist and in general only the recent data are suitable for any rigid comparing of sea temperatures from year to year.

St. Andrews Surface Temperatures.

Probably the best series of sea temperatures near enough to Subarea 3 for a possible temperature relation is the daily series of surface temperatures taken at St. Andrews, N.B. since 1921. (Hachey and McLellan, 1948). The combination of extremely high tides and narrow entrances to Passamaquoddy Bay forms an effective water mixing mechanism, consequently the surface temperatures at St. Andrews are fairly representative of the general temperatures of the ocean water in the area. The annual mean surface temperatures at St Andrews shown in Figures 1 to 4 were above or equal to the 1921-1947 average during the years 1927-33, 1936-38, 1944-47, and 1949-52. Judging by information from the Arctic, most of the years since 1922 may have been in a warmer period. The series is, therefore, not really extensive enough to trace long-term changes but it is useful as showing a trend toward higher temperatures in recent years and for showing any effect of higher and lower temperature short-term periods.

Since there is nothing comparable in Subareas 2 and 3 and since there is a good possibility that the St. Andrews temperatures reflect in some degree Subarea 3 temperatures, the St. Andrews temperatures will be used for comparison.

St. John's Air Temperatures.

From the Dominion Meteorological Station at Torbay Airport a series of mean monthly air temperatures has been obtained for St. John's Nfld. from 1872, with some breaks, until 1941. There is also a similar series for Torbay Airport, 5 miles from St. John's, from 1942 to 1952. From these the mean yearly temperatures have been calculated. For 46 months when records were taken from both St. John's and Torbay Stations in 1944-45 and 1948-51, the Torbay temperatures have been adjusted to represent St. John's temperatures and these adjusted temperatures have been used for 1942-52. (In the overlapping period Torbay temperatures were on the average 0.6°C. lower than St. John's temperatures).

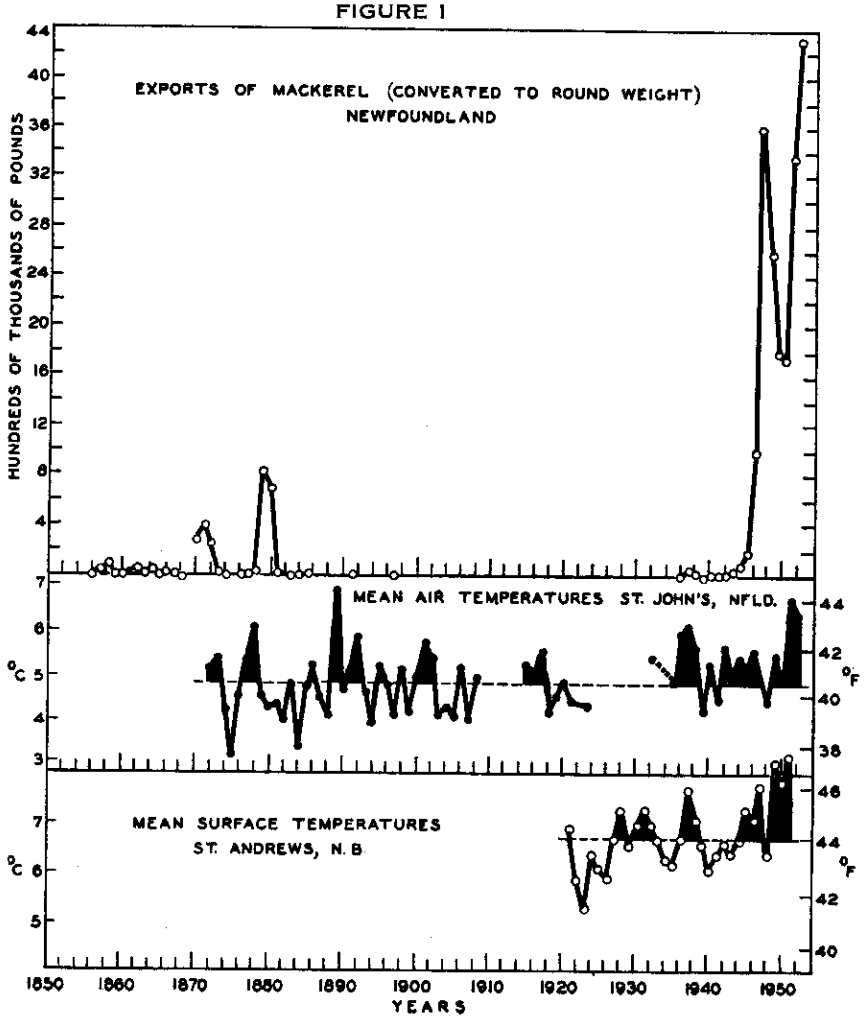
On each figure is shown the mean yearly air temperatures at St. John's for the available years between 1872 and 1952 and the mean yearly surface sea temperatures at St. Andrews, N. B. from 1921 to 1951. Extending through each temperature graph is an average line representing the average yearly temperature for the whole period at St. John's and at St. Andrews for most of the years for which temperatures are available. It will be noted that although mean air temperatures from year to year vary a number of degrees there is a gradually increasing temperature curve since the 1870's and 1880's with the past twenty years almost all above the average mean temperature for the whole period.

It is obvious also that there is a fairly good relation between high and low air temperatures at St. John's and corresponding periods of high and low temperatures of the sea water at St. Andrews. The average line at St. Andrews was calculated from the recent presumably warmer period 1921-47 whereas the average airtemperature at St. John's was derived by including the earlier colder period as well. Thus the St. Andrews average is possibly a half degree Centigrade or a degree Fahrenheit higher than it should be to compare with the St. John's average. There is probably a difference of not much more than 1½ degrees Centigrade between the mean sea temperature at St. Andrews and the mean air temperature at St. John's. It is certain that because of the location of St. John's its air temperatures will be strongly affected by the surface temperatures of the nearby Atlantic.

CHANGES IN ABUNDANCE OF MARINE ANIMALS IN SUBAREAS 3 AND 2.

In Subarea 3 there have been only two brief periods of research activity from the Newfoundland Fisheries Research Station, 1931 to 1935, and from 1946 to the present time. The long-term records of marine animal abundance, therefore, are those of marine animals taken commercially and from newspaper records of unusual species. In the following account all the old newspapers have not been thoroughly searched but the fisheries catch and export records have been investigated.

FIGURE 1



Mackerel.

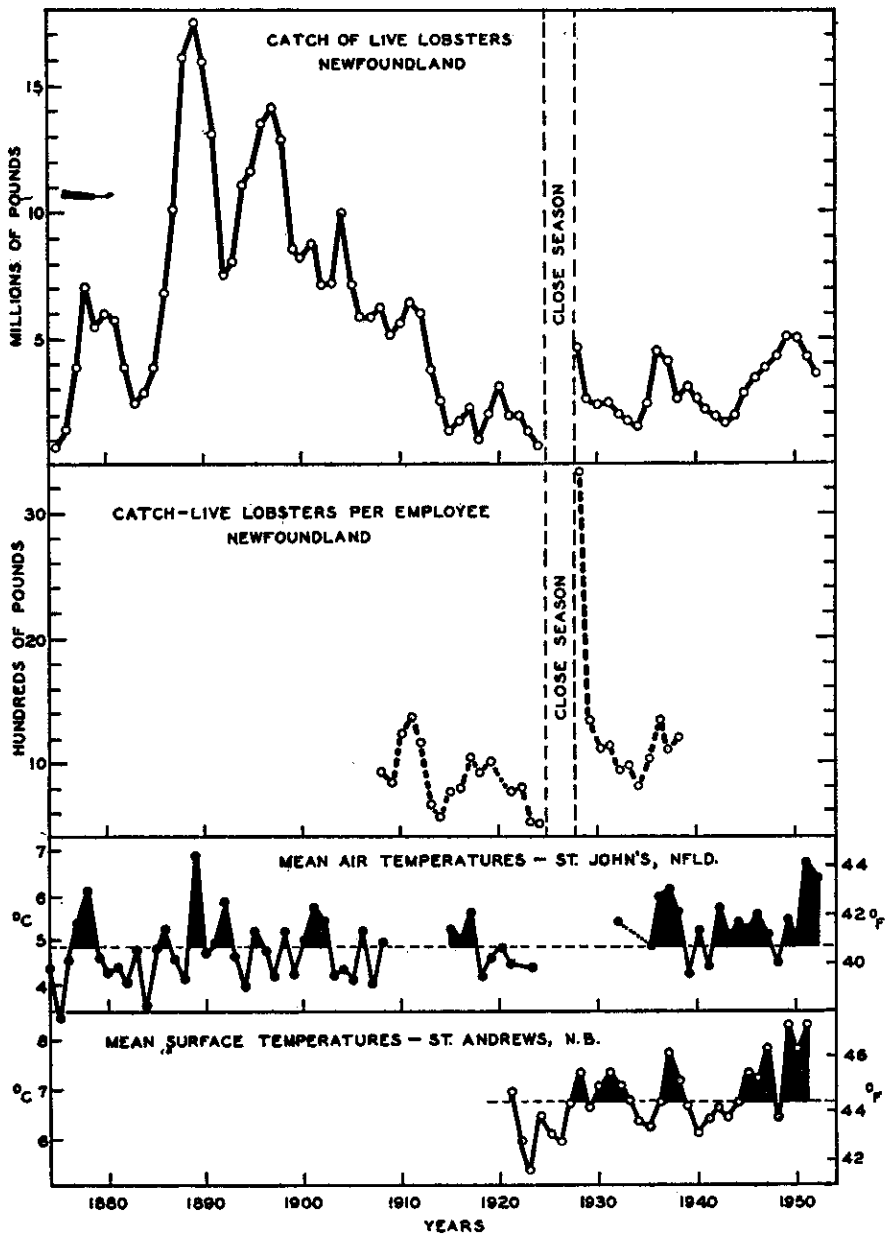
While they were doubtless present on the west coast of Newfoundland, mackerel were apparently absent or extremely scarce from the east coast of the island for many years prior to their recent appearance in numbers. In the senior author's early years at Bonavista in the middle of the east coast, although numerous cod traps were used with mesh small enough to catch mackerel, he can remember seeing only one mackerel.

A statement by Mr. L. G. Hodder from Ireland's Eye in Trinity Bay, one of the present large centers of the fishery, runs as follows—"Mackerel were almost unknown in Trinity Bay prior to the mid 1940's but since then have made their appearance in considerable quantities and a significant mackerel fishery has developed especially during the months of September and October each year."

The export figures for mackerel shown in Figure 1 indicate very small quantities, less than two hundred thousand pounds per year for the earliest figures available, 1856 to 1868; about three to four hundred thousand, 1870-72; and seven to eight hundred thousand pounds in 1879-80. Less than five thousand pounds were exported in each of the years 1883, 1884, 1885, 1891 and 1897, and otherwise there were no further exports until 1936. The exports of mackerel did not rise to two hundred thousand pounds again until 1945 after which the exports increased rapidly and ranged between approximately two to four million pounds from 1947 and 1952.

The recent increase in mackerel appears to be an increase in population presumably due to a recent warm period, the east coast being during cold periods a too-low-temperature environment for the success of this species.

FIGURE II



Lobsters.

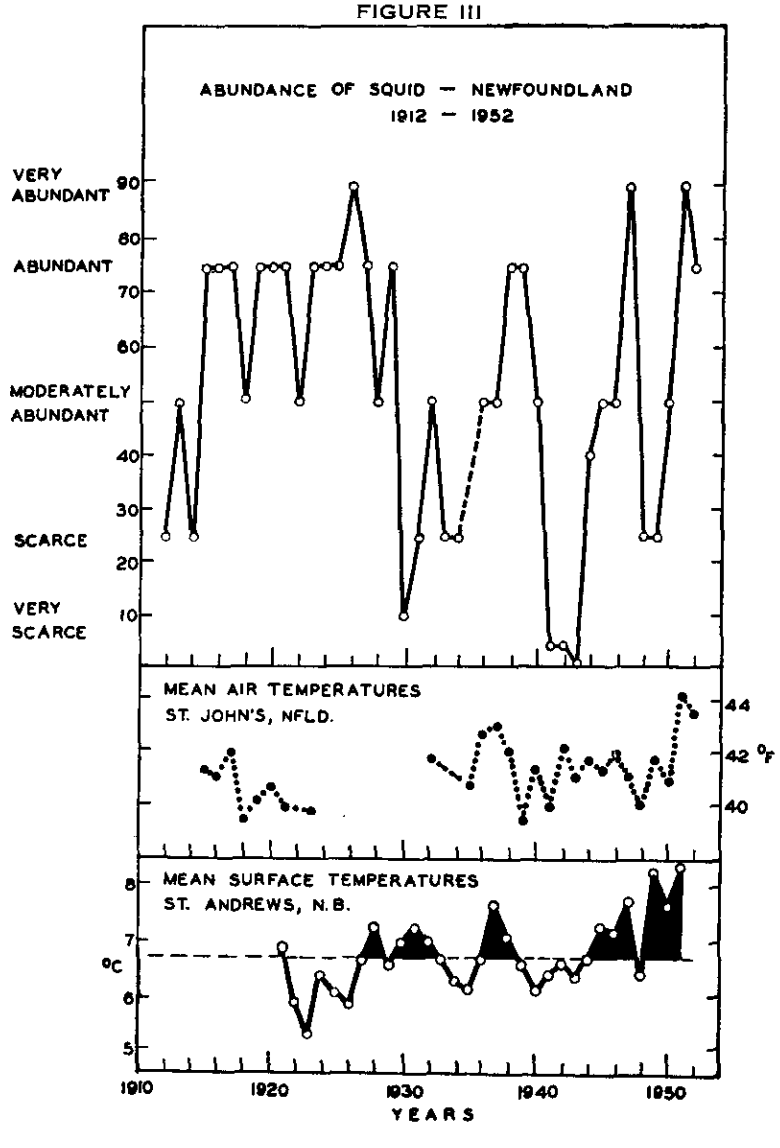
Figure 2 shows the relation of the catch of lobsters in Newfoundland to St. John's air temperatures and St. Andrews surface sea temperatures. In Newfoundland, lobsters were first caught commercially in the 1870's with the highest catch of sixteen to eighteen million pounds from 1888 to 1890. Over six million pounds a year were caught in almost all years between 1886 and 1912. The catch was at its lowest ebb between 1915 and 1924. In the recent twenty years there has been a fluctuating but on the average progressive increase in catch (for more complete information on the period up to 1939 see Templeman, 1941). There are only a few figures available on the number employed in the lobster industry.

The early large catch represented the fishing-out of a relatively abundant virgin stock. Since lobsters in Newfoundland, especially on the north-east coast, are at the northern limit of their range, any increase in temperature should be beneficial to the survival of the young and for ease of trapping the adults. It is

possible that the recent improvement in the fishery is a response to higher temperatures. If this is true, it is note-worthy that the increase has not been nearly as great as in northern Norway and in the north-eastern U.S.A. in Maine. Summer surface temperatures in Newfoundland lobster producing areas would probably be higher, however, than those in northern Maine so that Maine might benefit more by increased temperatures.

To consider shorter term trends in recent years since the early nineteen-twenties, it is evident by a comparison with St. Andrews temperatures that the three recent prolonged periods of below average temperatures correspond fairly well with decreases in the lobster catch. This correlation has already been pointed out by Martin (1953) for the lobster catch in the Maritime Provinces and is apparently due to the fact that temperature controls feeding rate and rate of movement and thus affects the capture of lobsters in baited traps. In the limited information available the catch per employee is similar in trend to the total catch.

FIGURE III



Squid

The squid *Illex illecebrosus* is seasonally very common in the Newfoundland inshore area. Squid can usually be caught at a depth of about a hundred fathoms or over on the south-west edge of the Grand Bank in May. They gradually move shoreward across the bank and are numerous in the inshore areas usually in late July or early August, leaving again in November. In some years they may be extremely abundant and in other years scarce or absent. When inshore they are in the warmer and shallower water only several fathoms deep. From its habits one would expect this animal to be associated with rather warm water.

The only long-term information available is qualitative from fisheries reports and other sources indicating abundance. The various degrees of abundance have been given a numerical rating and from this rating the graph below has been drawn (Figure 3). It is seen that contrary to what might be expected there has been no increase in abundance in recent years. There was a period of general abundance with no very bad years between 1915 and 1929, generally lesser abundance from 1930 to 1934, a period of extreme scarcity from 1941 to 1943 and of relative scarcity in 1948 and 1949. There have been more periods of scarcity and greater average scarcity since 1930 than in the fifteen years previous to 1930. We are unable to draw inferences regarding the possible long-term effects of water temperatures.

If short-term local abundance of squid is considered, using St. Andrews temperatures it will be noted that the 1934, 1941 to 1943 and the 1948 lack of abundance occurred during periods of below-average temperatures while the 1930, 1931 and 1949 low abundance occurred with above-average temperatures. The 1922-26 period of considerable abundance occurred during periods of below-average temperatures.

Billfish (*Scomberesox saurus*)

In recent years billfish have often been abundant in Newfoundland waters. Our earliest record is for 1885 when billfish were reported abundant in September in Torbay Harbour. From 1931 to 1934 there are some individual records of billfish by the Fisheries Research Station. In 1936 billfish were plentiful at Bay Bulls and Dildo. The correspondent reported that some had been caught at Bay Bulls thirty years previously. In 1945 the newspaper correspondent from St. Fintan's on the west coast of Newfoundland reports that a school of billfish was encountered. The correspondent says that this fish is a newcomer, he has only heard of them recently. In 1947 in October and November billfish were present in great numbers in Conception Bay. In early October a very large catch was made at Harbour Breton on the south coast while mackerel were being seined. These were the first the correspondent had ever seen. Mr. Colin Storey seined 40 barrels in Trinity Bay in a day during the first week of October. On November 13 and 20, thousands of billfish were driven ashore at Holyrood in a storm. In 1951, billfish were extremely numerous in September and October on the east coast of Newfoundland in Notre Dame, Bonavista, and Trinity Bays. While we cannot be certain of billfish abundance during the years between 1885 and 1931 from absence of records, it seems to be fairly certain judging by the lack of knowledge of billfish among the local population when they became abundant in recent years, that they had not been generally in evidence in numbers for a considerable time previously.

Capelin (*Mallotus villosus*)

The capelin is abundant throughout the Newfoundland area, is near the southern part of its range on the warmer southwest part of the Newfoundland coast and might thus be expected to show variation in abundance with changing climatic conditions.

In Newfoundland, capelin are used mainly for bait and for fertilizer, consequently no record of former abundance can be found in the fisheries statistics. Over most of the coast it rarely fails to appear in numbers. On the western part of the south coast and the southern part of the west coast of Newfoundland, however, by the time capelin are ready to spawn, inshore temperature conditions in warm periods may often be too high for the beach spawning which occurs on all suitable beaches on the colder east coast of the island.

The latest reports on capelin abundance in the Newfoundland area were obtained by a questionnaire in 1941 (Templeman, 1948). It was apparent that in the period between about 1929 and 1940 or later there was an inshore scarcity of capelin on the warmer parts of the Newfoundland coast. From the western part of the south coast, with centre at Burgeo, we have the report in 1941 from the fisheries inspector that capelin had been plentiful in every year until 1929 and none had spawned there since.

From Bay L'Argent and English Harbour West, Fortune Bay, two fisheries inspectors reported separately in 1941 that this year saw the first appearance of the capelin in many years. The fishery inspector at Port aux Basques reported regarding the area from Cape Ray to Fox Roost in 1941 that there had not been any capelin in the area for ten to fifteen years.

Cod

Figures for cod exports and export values of dried salt cod are available since 1807. For purposes of the graph shown below (Figure 4), the exports in recent years of fillets have been converted to dried salted cod. Unfortunately there is no record of the number of fishermen engaged except for a brief recent period.

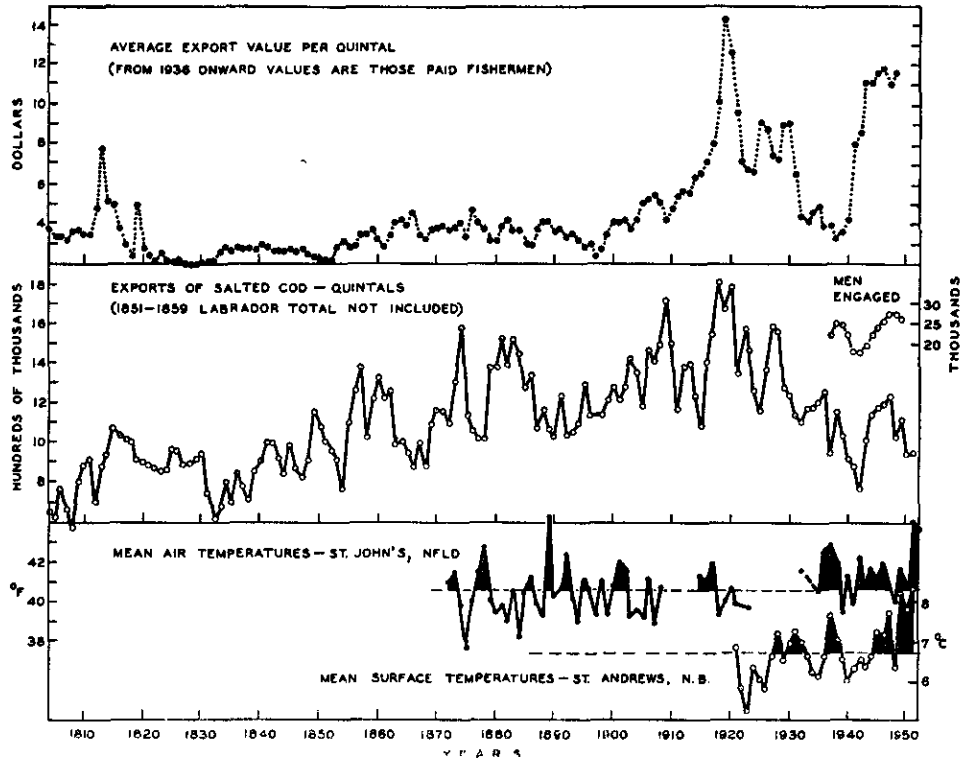
During the period under review, the cod catch largely inshore in Newfoundland and Labrador gradually increased to an average of almost one million eight hundred thousand quintals

of dried salted cod from 1918-1920 and has since gradually declined to about a million quintals.

Some of the increases in catch seem to coincide with or follow price increases. In the early part of the fishery the highest price was reached in 1813 during the Napoleonic wars. The general high prices of the period were soon followed by an increase in catch with a peak catch in 1815. The high prices during and immediately after the first World War with a peak price in 1918 also corresponded with the peak catches of the whole period. The catch continued at a very high level until 1920 when prices fell rapidly and this was followed by a decrease in production. The very low prices of the depression period from 1931 to 1940 corresponded with a severe reduction in the catch and the increased prices from 1941 onward did not immediately result in the production of a large catch since the number of fishermen declined rapidly through overseas service and because during the early war years large numbers of fishermen gave up fishing to work at the construction of military bases in Newfoundland. Following the return of the fishermen to their fishing trade and with prices still high, the catch increased correspondingly. Still more recently the dory-schooner fishery for cod on the Grand Bank and the schooner fishery for cod on the Labrador coast have been largely abandoned for lack of crews. Many of the fishermen, particularly the younger ones, have again left the fishery to engage in construction and other work. Since these two fisheries have a much greater production per man than the Newfoundland inshore fishery and since there is a reduction in the numbers of inshore fishermen also, there has been an inevitable reduction in total catch. The trawlers which are taking the place of the dory-schooners do not usually fish for cod.

Both the increase in catch from 1870 to 1920 and the decline in the cod catch since 1920 have apparently been in a period of increasing temperatures with the temperatures since 1930 being considerably higher. However, so many other factors are responsible for fluctations in the catch of cod throughout the years that it is very doubtful whether lack of abundance or availability of cod has had anything to do with the overall decline in catch.

FIGURE IV



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