INTERNATIONAL COMMISSION FOR THE NORTHWEST ATLANTIC FISHERIES

REDBOOK 1970 PART III

SELECTED PAPERS FROM THE 1970 ANNUAL MEETING

Note

REDBOOK 1970 appears in 3 books. The first book contains Part I, Proceedings of the Standing Committee on Research and Statistics. The second book contains Part II, Reports on Researches in the ICNAF Area in 1969. The third book contains Part III, Selected Papers from the 1970 Annual Meeting.

prepared by Valerie L. Caton

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PART III. SELECTED PAPERS FROM THE 1970 ANNUAL MEETING

CONTENTS
(continued)

SECTION A

OCEANOGRAPHY

1. Hydrographic Conditions off West Greenland during 1969[1]

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From the R/C *Adolf Jensen*, section I off Frederikshaab was worked in February and September, section II off Fylla Bank was worked in February, March, April, May, June and August, section III off Lille Hellefiske Bank was worked in April, June and August and section IV off Store Hellefiske Bank was worked in June and August (Fig. 7).

Characteristic in 1969 was the great amount of polar ice which was transported by the East Greenland Polar Current around Cape Farewell and northward along the west coast of Greenland. By May the ice reached as far north as Godthaab (64°N). Its maximum extension was about 66°N. Comparison with ice maps from earlier years shows that 1969 was one of the most severe ice years in this century.

The temperature sections are shown in Fig. 1-6. The sections from February and March show that the winter cooling caused low temperatures over the shallow part of Fylla Bank, but the cold water layer was relatively thin and found mainly in the upper 50 to 75 m. Below 100 m the temperatures were about 1°C higher than those found in 1968.

During the following months the water layer above 100 m remained unusually cold. Even in August water with below zero temperature was found over the western slope of Fylla Bank and Lille Hellefiske Bank which is quite unusual. The reason is probably that the melting and the reflection of heat radiation of the great amounts of sea ice counteracted the usual summer heating of the surface water.

In the water layers below 200 m the temperatures were about normal and considerably higher than in 1968.

The influence of the cold water masses was less pronounced over Store Hellefiske Bank in June and August than over the more southerly banks. Apparently the greatest part of the cold component of the West Greenland Current had bent westward off Lille Hellefiske Bank.

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[1] submitted to the 1970 Annual Meeting of ICNAF as ICNAF Res.Doc.70/11

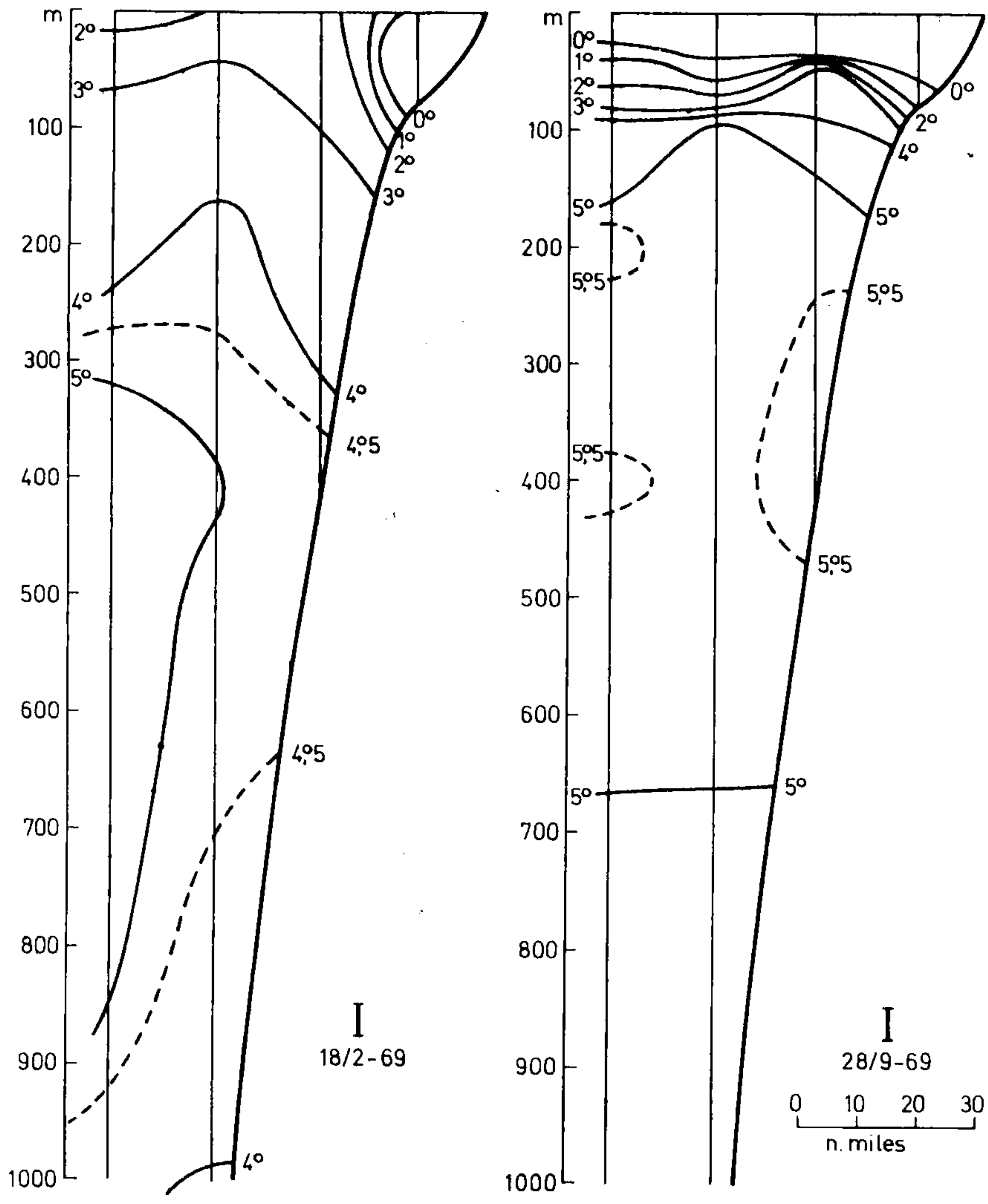


Fig. 1. Vertical temperatures off Frederikshaab (Section I) in February and September 1969.

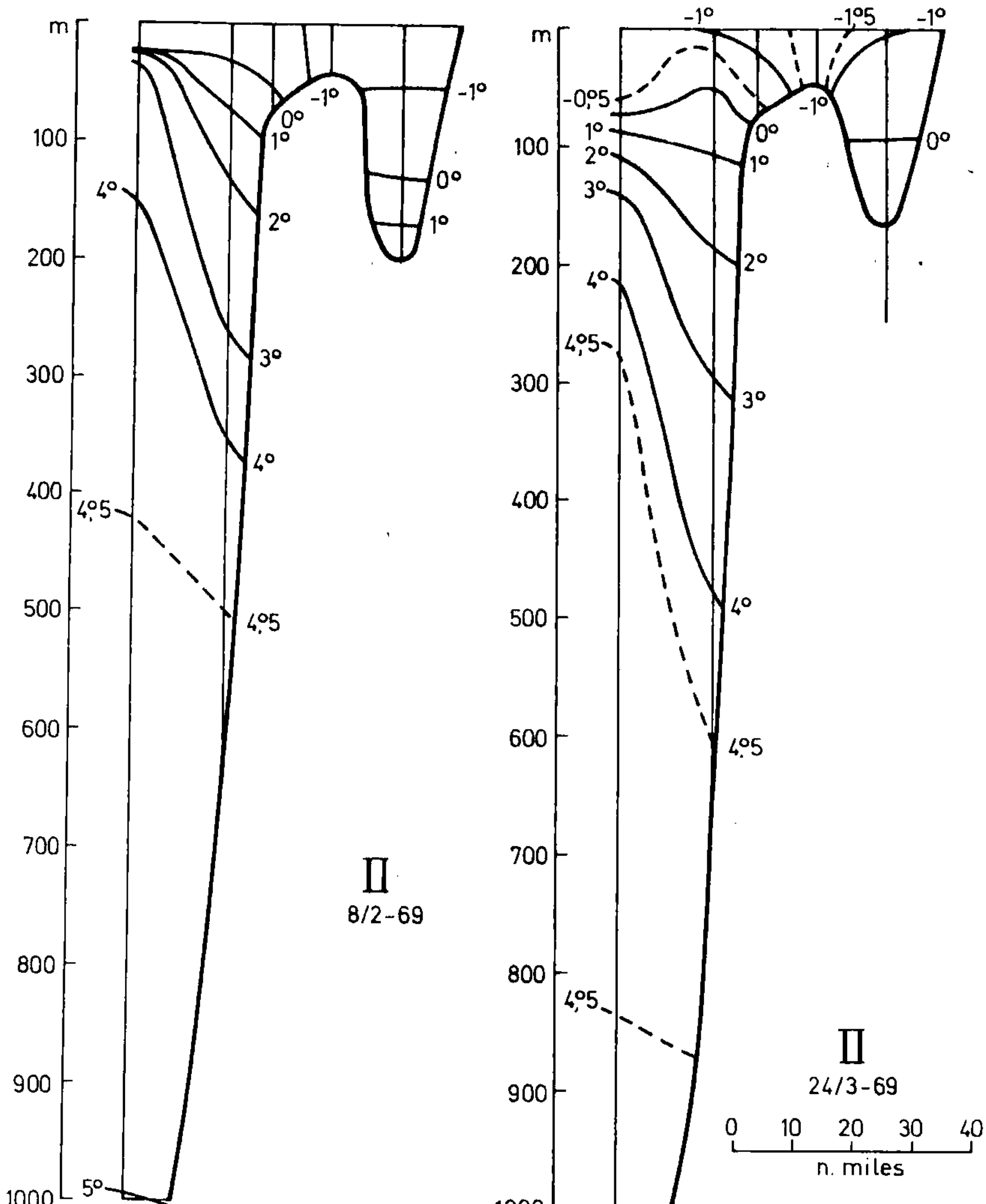


Fig. 2. Vertical temperatures off Fylla Bank (Section II) in February and March 1969.

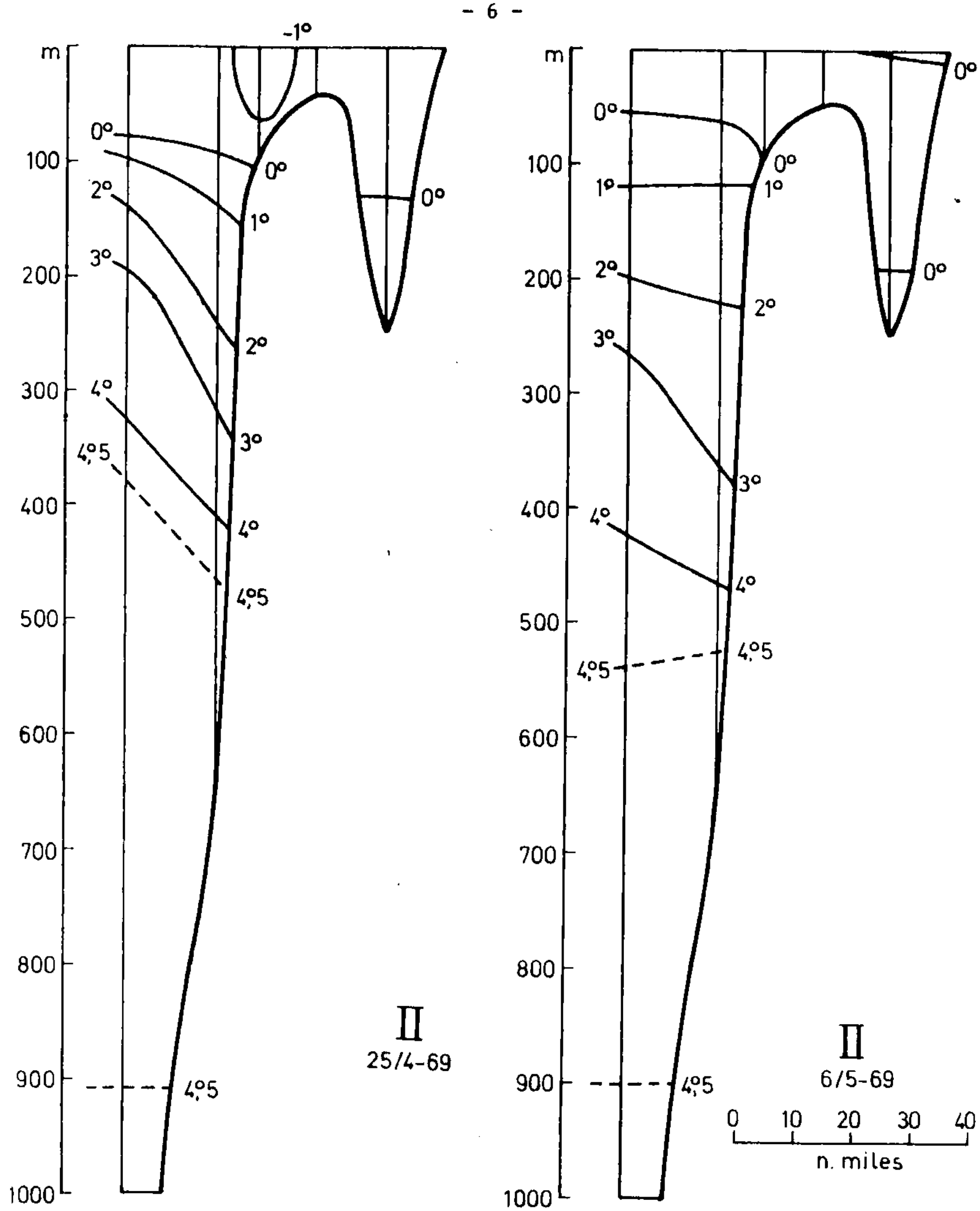


Fig. 3. Vertical temperatures off Fylla Bank (Section II) in April and May 1969.

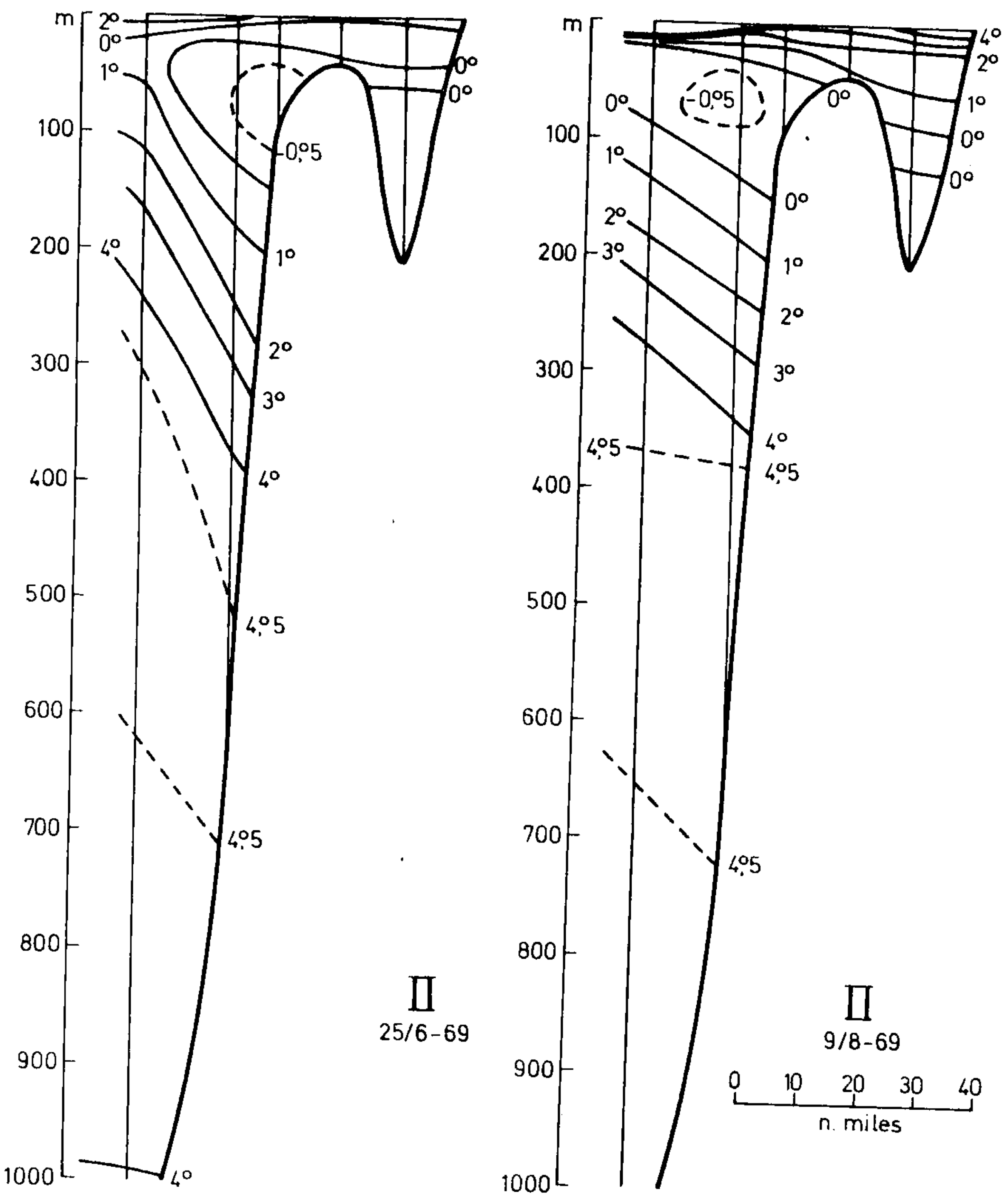
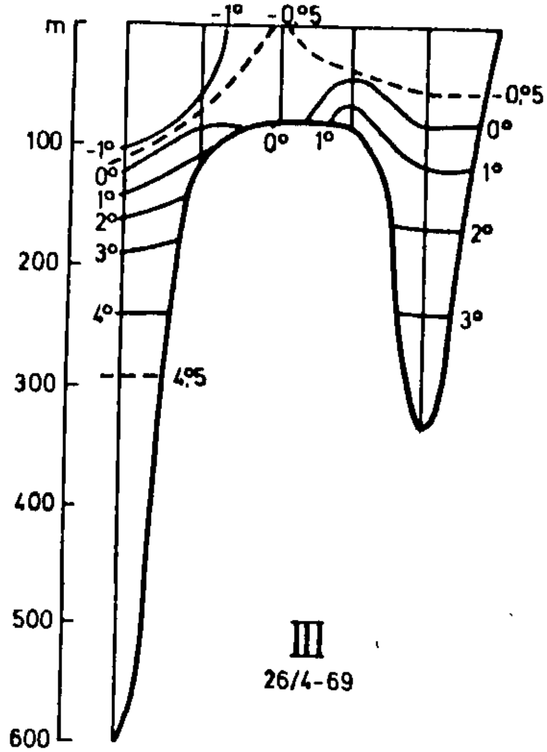
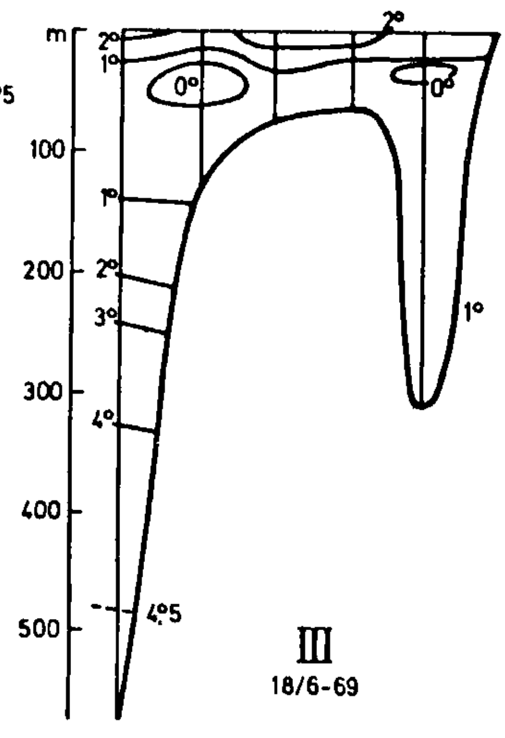


Fig. 4. Vertical temperatures off Fylla Bank (Section II) in June and August 1969.





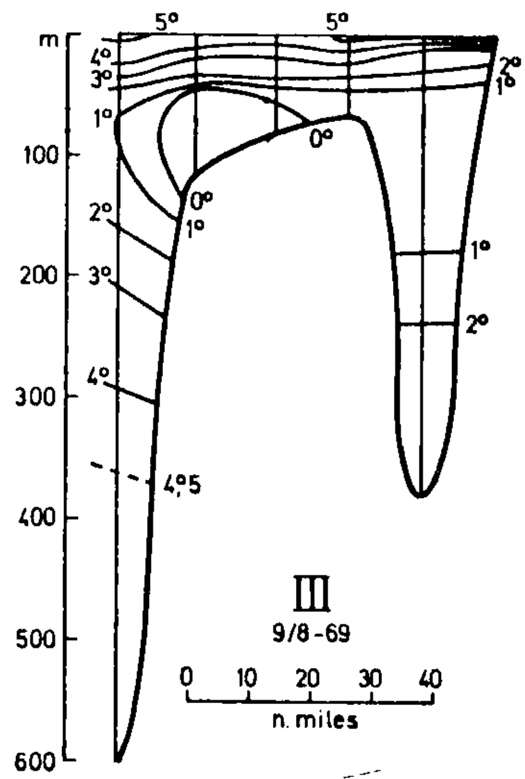


Fig. 5. Vertical temperatures off Lille Hellefiske Bank (Section III) in April, June and August 1969.

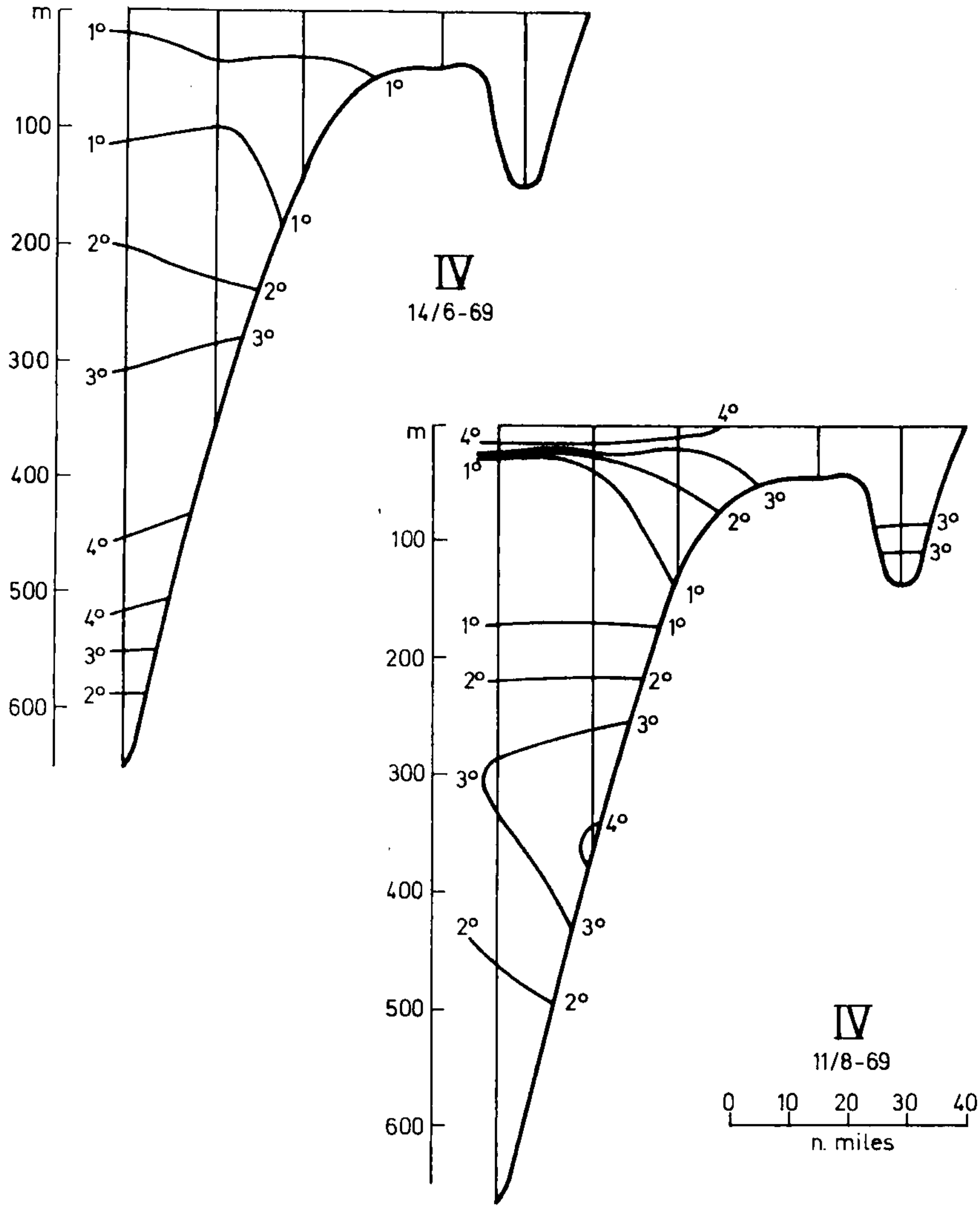


Fig. 6. Vertical temperatures off Holsteinsborg (Section IV) in June and August 1969.

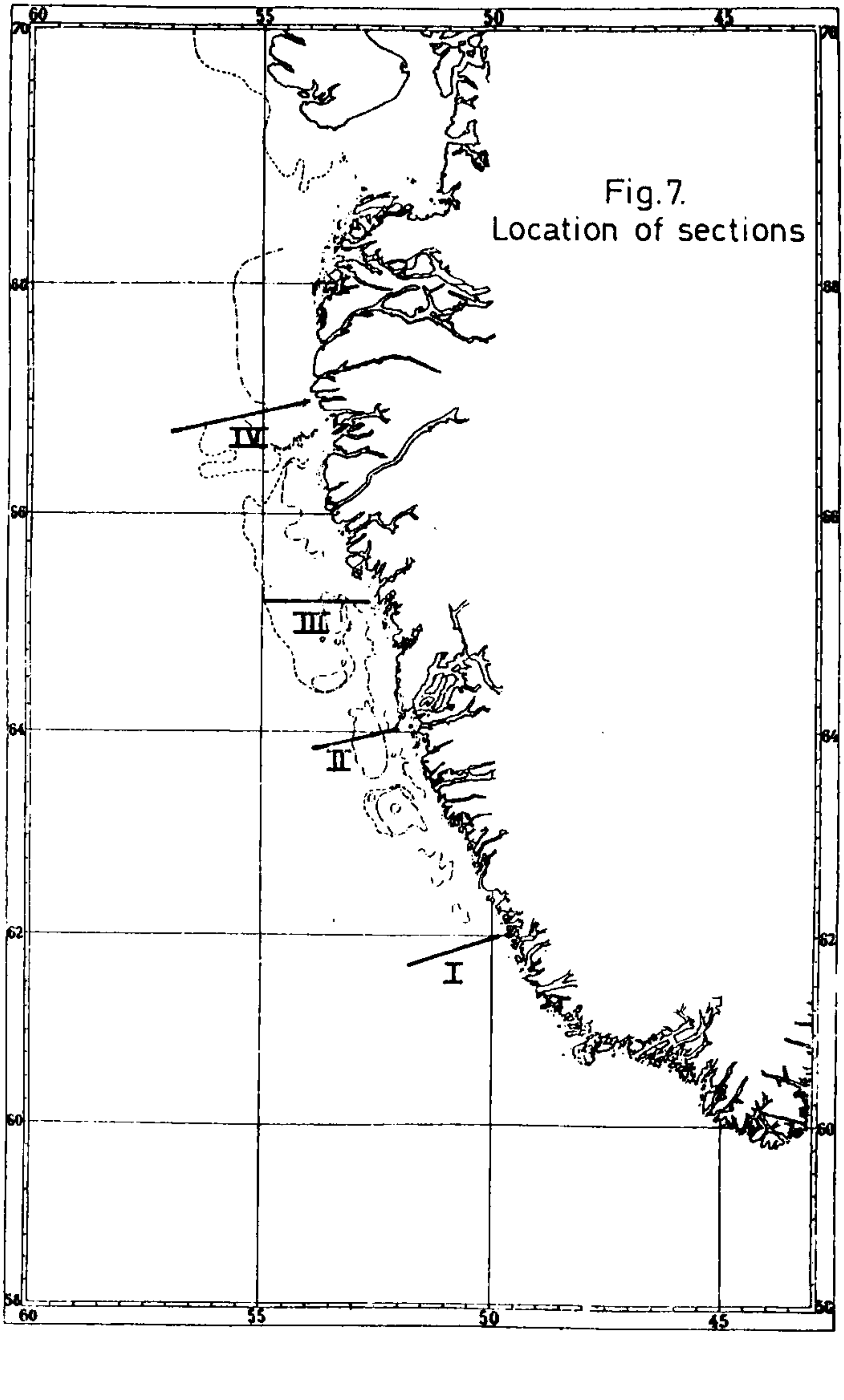


Fig. 7.
Location of sections

2. Temperatures and Salinities in the Eastern Newfoundland Area in 1969[1]

by Wilfred Templeman
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Introduction

After three years in which only the St. John's-Flemish Cap section was taken, the 6 standard sections taken yearly on approximately the same dates in July-August across the Labrador Current east of Newfoundland from 1951 to 1965 were occupied in 1969 by the *Cape Freels* operated for two cruises by the St. John's Station. Station 27, off Cape Spear, was occupied monthly or oftener throughout the year. The section temperatures will be compared with the lowest, average and highest temperatures at each depth at each station in 1951-65 in July-August. For the St. John's-Flemish Cap section it will be possible to make some comparisons also with sections taken in 1966-68.

Sections across the Labrador Current in July-August

Temperatures

In the Seal Islands, Labrador section across Hamilton Inlet Bank (Fig. 1), surface temperatures were a little above the average but the temperatures of the intermediate water over the Continental Shelf at some levels at several offshore stations were below the lowest previously recorded in this section and near the coast only about 0.1 to 0.2°C above the lowest recorded. The volume of water below -1°C was also much greater than usual. The deep water in Hawke Channel west of Hamilton Inlet Bank was colder than the average but 0.25 to 0.8°C higher than the lowest temperatures recorded.

In the section off Cape Bonavista (Fig. 2), surface temperatures in most of the section were slightly above average but in three seaward stations slightly below average. The amounts of cold water below 0°C and below -1°C were slightly greater than average and the coldest water 0.1°C lower than average. The part of the section intersecting the northern Grand Bank along the 50° longitude line (Fig. 2) has not been taken for enough of the 1951-65 period to be included in the averages. This section intersects the portion of the Labrador Current passing to the eastward and the comparisons with previous years and averages should be approximately the same as in the Cape Bonavista section.

In the St. John's-Flemish Cap section (Fig. 3), surface temperatures were about average. Temperatures generally in the water below 0°C in the shoreward part of the Avalon Channel at some depths and at the bottom were among the highest encountered in this section. Also in this part of the section the volume of water below 0°C was less than usual and only slightly greater than the least recorded. In this part of the section also, the volume of water below

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-1°C was much less than average but the lowest temperature, -1.47, was lower than average. Seaward over the surface of the Grand Bank, temperatures were slightly higher than average and the volume and temperatures of the eastern cold water part of the Labrador Current on the eastern slope of the Grand Bank were close to the average. Temperatures in the Flemish Channel, on Flemish Cap and on the eastern slope of Flemish Cap were above average but usually not as high as in 1968.

In the section from St. John's to the southeast slope of the Grand Bank (Fig. 4), surface temperatures over the Grand Bank were close to the lowest previously encountered but over the Avalon Channel and southwest of the Grand Bank were higher than the lowest but still below average. The low surface temperatures over the bank were partly due to the mixing of the upper layers, as the depth of the 10°C isotherm was greater than average. The volumes of water below 0°C and below -1°C in the Avalon Channel were somewhat less than average but the lowest temperature of this water was 0.06°C below average. Bottom temperatures in the Avalon Channel were slightly higher than any previously recorded for this section. Bottom temperatures over the Grand Bank were higher than average, and the temperatures and volume of the water below 0°C on the southeastern slope of the Grand Bank close to the average. The 0 to 5° isotherms on the southeastern slope were much closer together than usual, the temperatures at 20-200 m at Station 33B and at 20-400 m at Station 33F were higher and above 300 m at 33F much higher than any previously encountered in this section.

In the section extending along the southwestern edge of the Grand Bank (Fig. 5), at about 75 m, surface temperatures were below average but this was partly, at least, due to the mixing of the upper layers as the 10°C contour extended more deeply than usual. Bottom temperatures over the bank were close to the average but in the Haddock Channel were about 0.3°C higher than any previously recorded for this section. The lowest temperatures in the Labrador Current section on the southeastern slope of the Grand Bank were close to the average and the volume of cold water below 0°C was less than the average.

In the section at 275 m along the southwestern slope of the Grand Bank and extending to St. Pierre Bank (Fig. 6), the temperatures of the southward flow of Labrador Current water through the Halibut Channel in 75-100 m at Station 10 were a little below the average. The temperatures of the eastern and central cold water (the eastern certainly and the central most likely derived from the eastern branch of the Labrador Current) were slightly lower than average and close to the usual volume. The deep water and bottom temperatures over the bank slope were intermediate between the average and the highest temperatures of the 1951-65 period.

Salinities

In these comparisons, salinities from 20 m to the surface are omitted as being too much influenced by local and temporary precipitation and runoff for useful comparison from year to year. In the Seal Island section off southern Labrador (Fig. 1), salinities at 30 m and deeper at the various stations were almost always below average and usually in the lowest quarter of the 1951-65, 1969 period. At 400 and 500 m at Station 56, salinities were among the highest in the period but at these levels variations in salinity from year to year were small.

In the Bonavista sections (Fig. 2), salinities at 30 m and deeper were almost all well below average, usually in the lower part of the lower quarter, and many of the salinities, especially at Stations 48 and 49, were the lowest yet encountered.

In the Flemish Cap section (Fig. 3) for which comparisons are available for the period 1951-68, at Stations 27, 28 and 37 (including the lowest temperatures) salinities were all below average and usually in the lower quarter. At Stations 34-36 and 37A-42, salinities were below average, usually in the lower quarter at the 30 m level, increasing in the deeper layers, usually to well above average. At the outermost station, 42A, for which there are records for only 1961-69, upper layer salinities down to 200 m were below average, in the lower part of the lower quarter, whereas all salinities from 250 to 1,000 m were the highest yet recorded.

In the section from St. John's to the southeast slope of the Grand Bank (Fig. 4), at Stations 27, 28, 33A, and 33D most salinities were well below average, although at bottom at Station 27 and from 400 m to bottom at Station 33A they were above average. At other stations also, out to and including Station 33, salinities at 30 m were lower than usual, generally in the lower quarter, whereas the deeper levels were mostly near or above average. At Station 33B, salinities were above average from 30 to 150 m, with salinities at 50-100 m the highest on record. Salinities were below average from 200 to 300 m and slightly above average from 400 m to bottom. At Station 33D salinities at all levels to bottom were below average and usually in the lowest quarter. At the outer station, 33F, salinities at all levels were near or at the highest recorded.

In the section at about 80 m extending along the southwestern edge of the Grand Bank (Fig. 5), salinities at 30 m were below average and usually the lowest recorded (but at this level records are only for 1959-65 and 1969). Also salinities at three of the colder water stations, 20A, 20B and 26A were below average, except near bottom at 20A. At the other stations out to and including Station 26D, salinities below 30 m were generally well above average. At the most easterly station, 26F, salinities were above average except at 30-50 and 250-300 m.

In the section at 275 m along the southwestern slope of the Grand Bank and extending to St. Pierre Bank (Fig. 6), salinities at 30 m were mostly below average. Almost all the other salinities were above average, apart from those at Station 10 where salinities at 3 of 7 levels (those at 200 m to bottom) were below average, and at Stations 13, 17 and 19 where the bottom salinities were below average.

Station 27, 1969

Winter-spring temperatures from surface to bottom at Station 27 off Cape Spear (Fig. 7) were higher than the 13-year average, 1950-62 (Templeman, 1965), apart from the low January temperatures at 150 m and bottom which were the effects of low temperatures generated in the previous year. For the remainder of the year, surface and bottom temperatures were close to the 13-year average. In June-December, intermediate water temperatures also were close to the average except that temperatures from June to early September at the 50 and 75 m levels were below 0°C and well below the 13-year average because in these months at these levels the average temperatures are above 0°C. The cold water below -1°C was not formed at Station 27 but arrived from northward in June and persisted in small amounts until early October, the lowest Labrador Current temperatures, as usual, gradually extending deeper as the year advanced.

Salinities did not differ greatly from those of 1968 (Templeman, 1969).

Acknowledgements

I am grateful to Mr A.G.Kelland, hydrographic technician at the St. John's Station, for providing a good deal of the data for this paper also to the scientists and technicians of the St. John's Station who have taken hydrographic observations at Station 27 and on the various sections.

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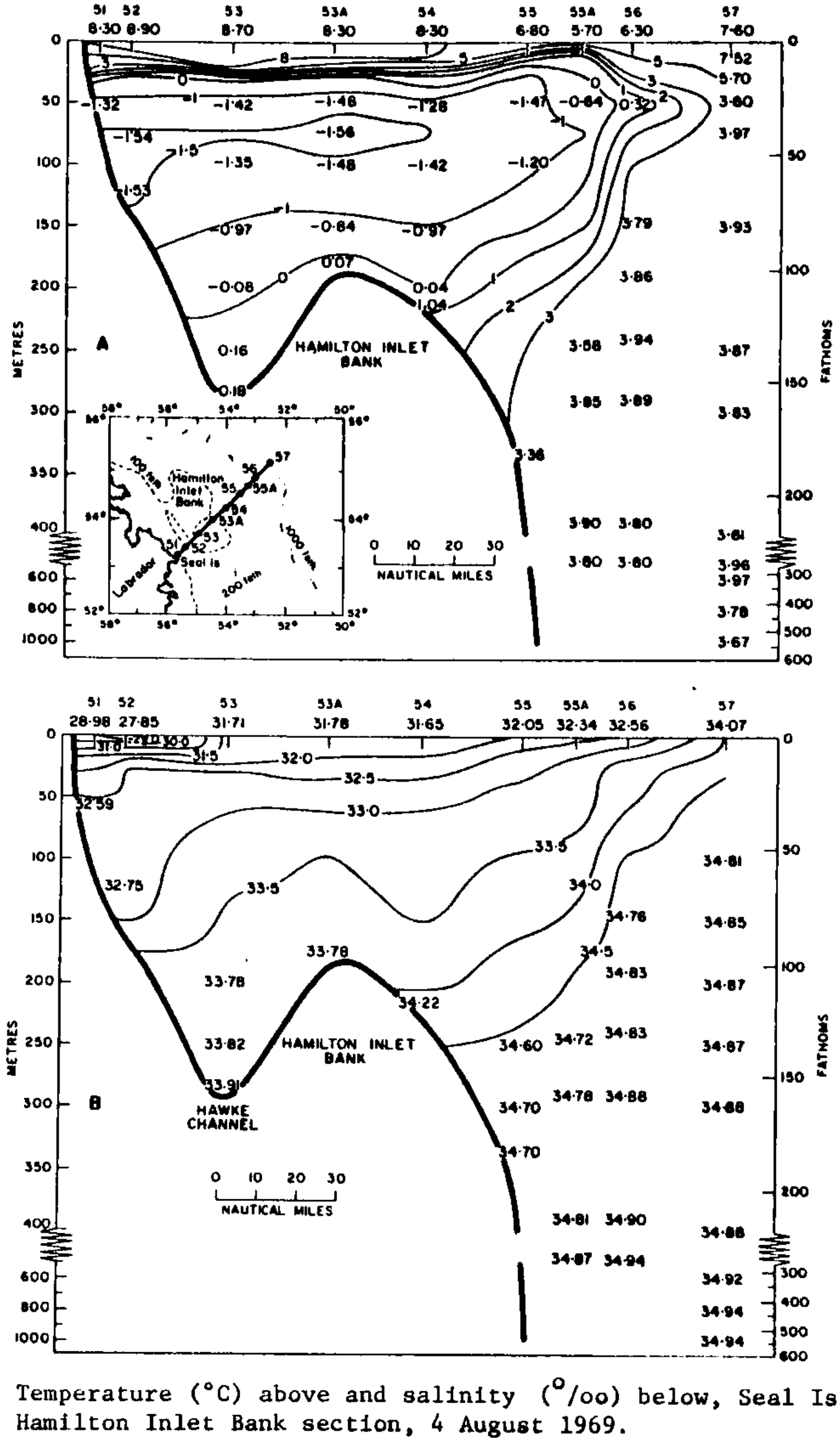

Fig. 1. Temperature (°C) above and salinity (^{o}/oo) below, Seal Island-Hamilton Inlet Bank section, 4 August 1969.

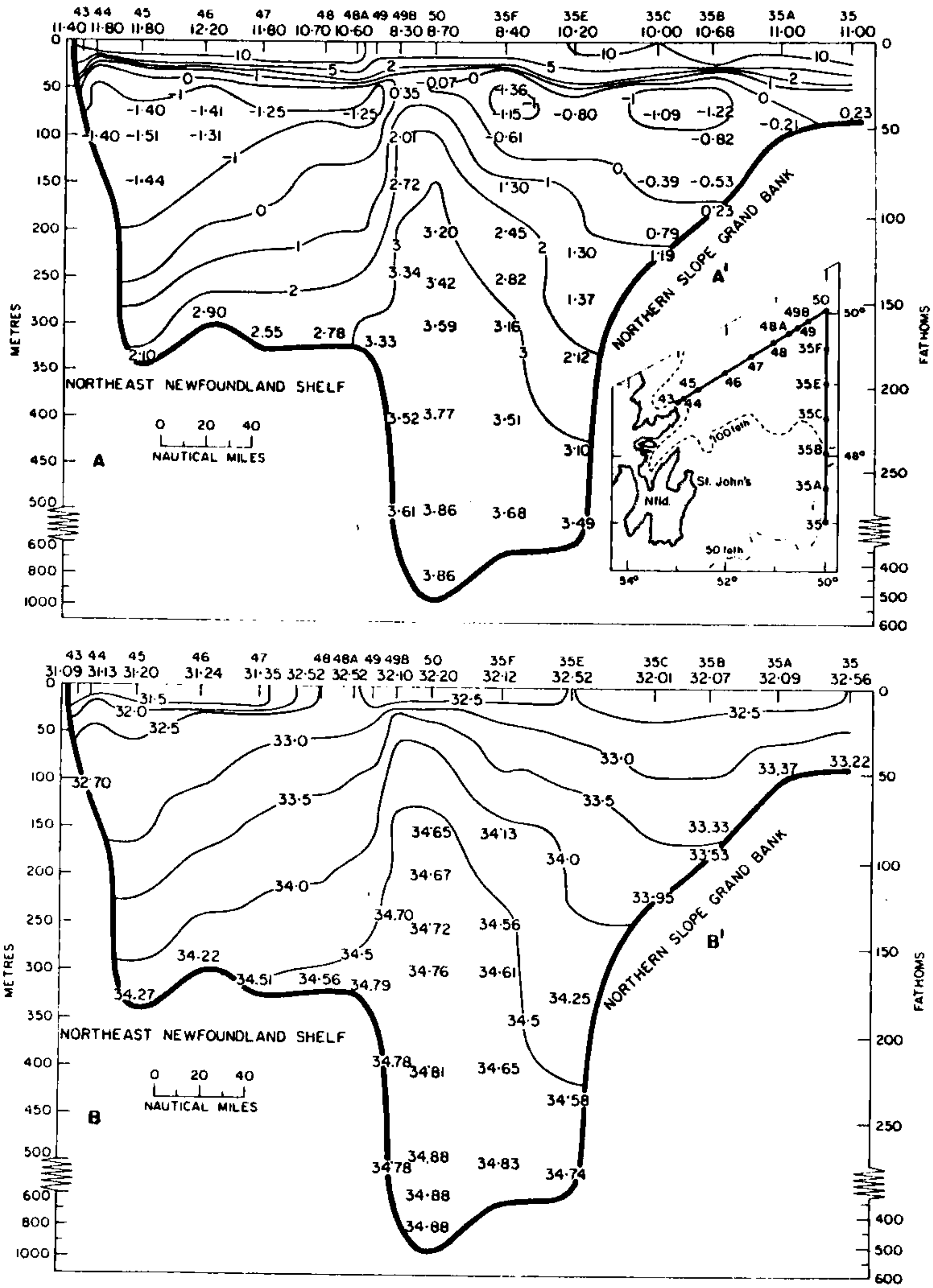

Fig. 2. Temperature (°C) above and salinity ($^{o}/oo$) below, for section off Cape Bonavista, 2–3 August, and southward to northern Grand Bank, 29 July–1 August 1969.

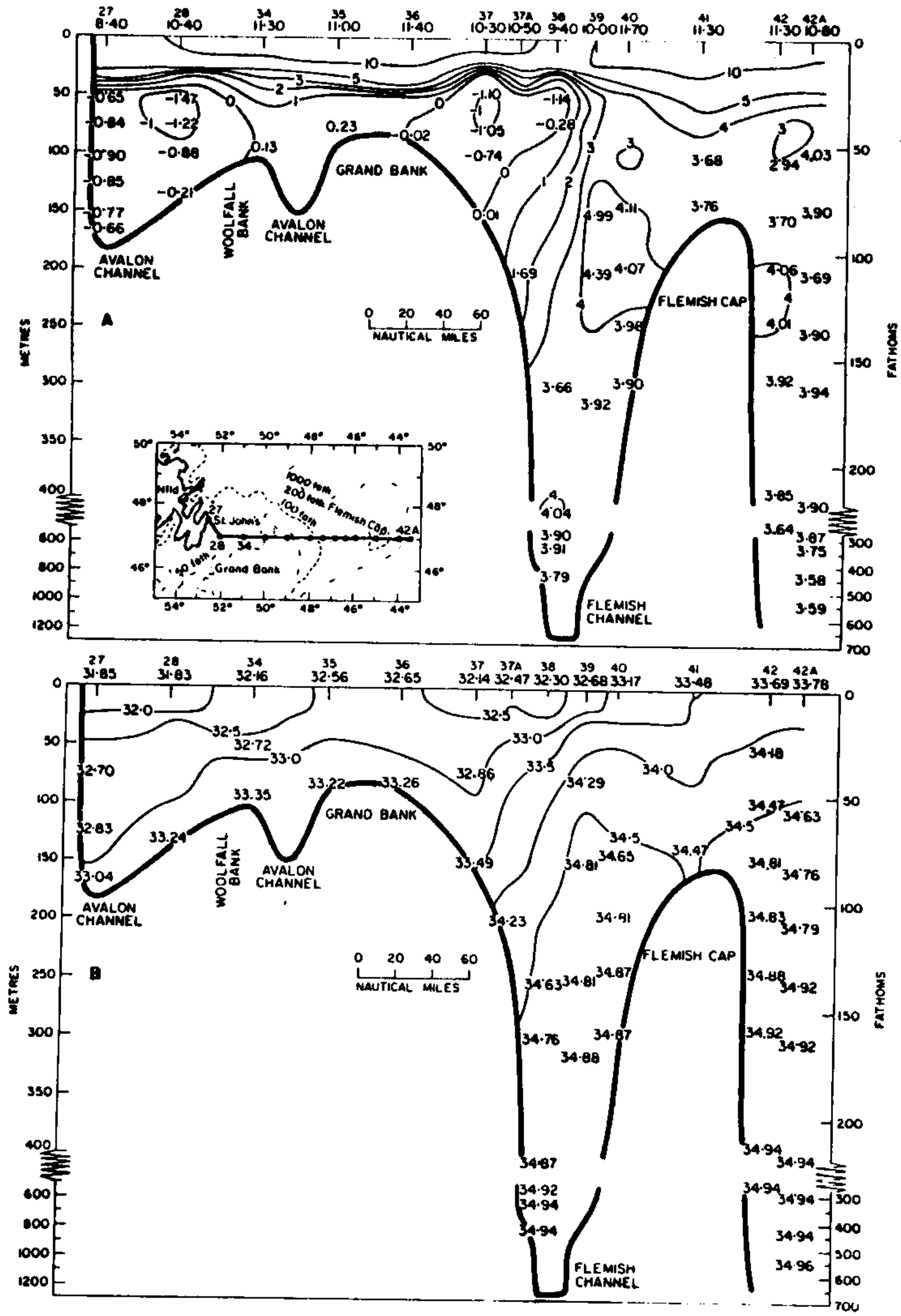

Fig. 3. Temperature (°C) above and salinity (°/oo) below, St. John's-Flemish Cap section, 29-31 July 1969.

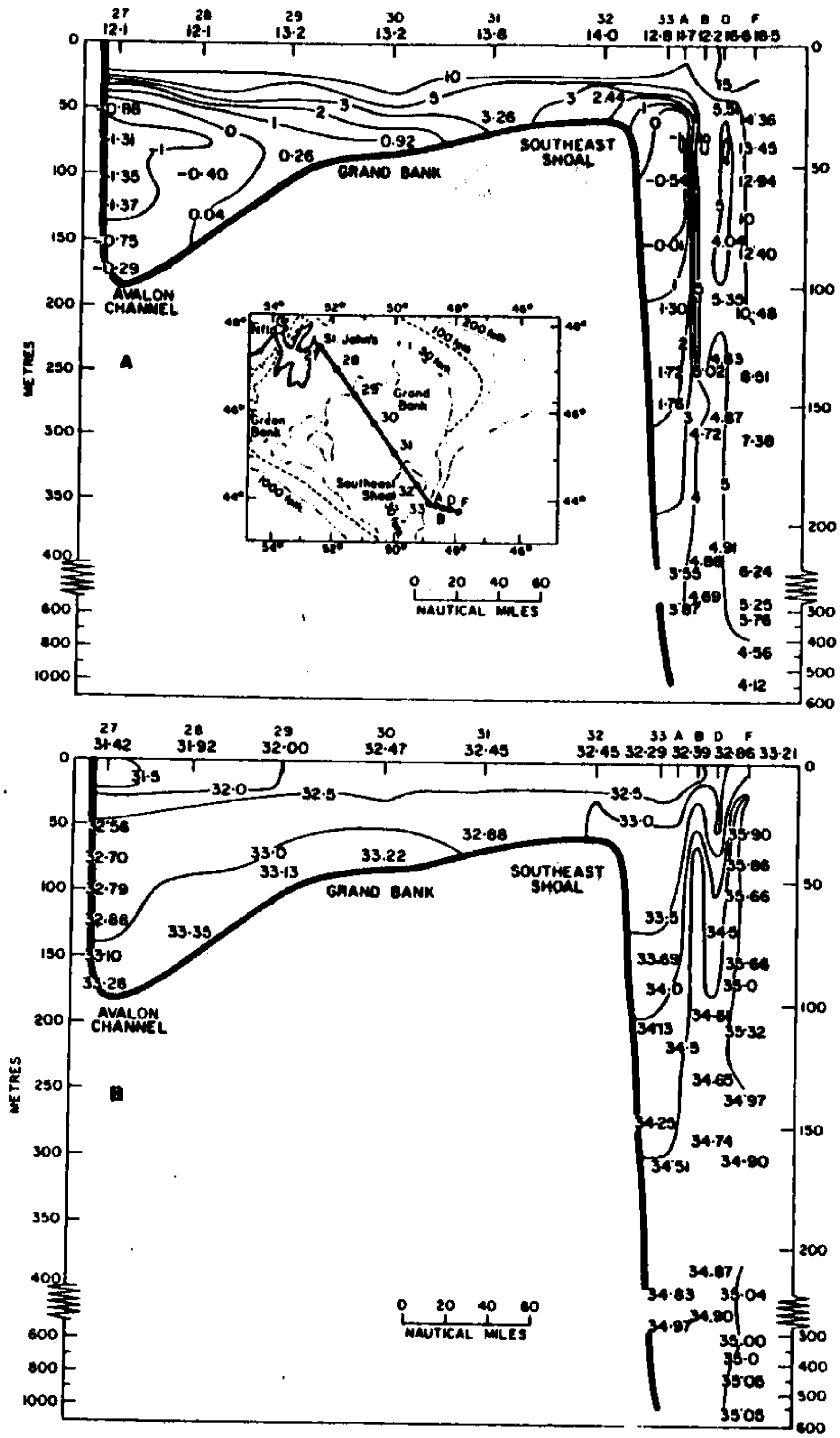

Fig. 4. Temperature (°C) above and salinity ($^{o}/oo$) below, St. John's-SE slope Grand Bank, 18-20 August 1969.

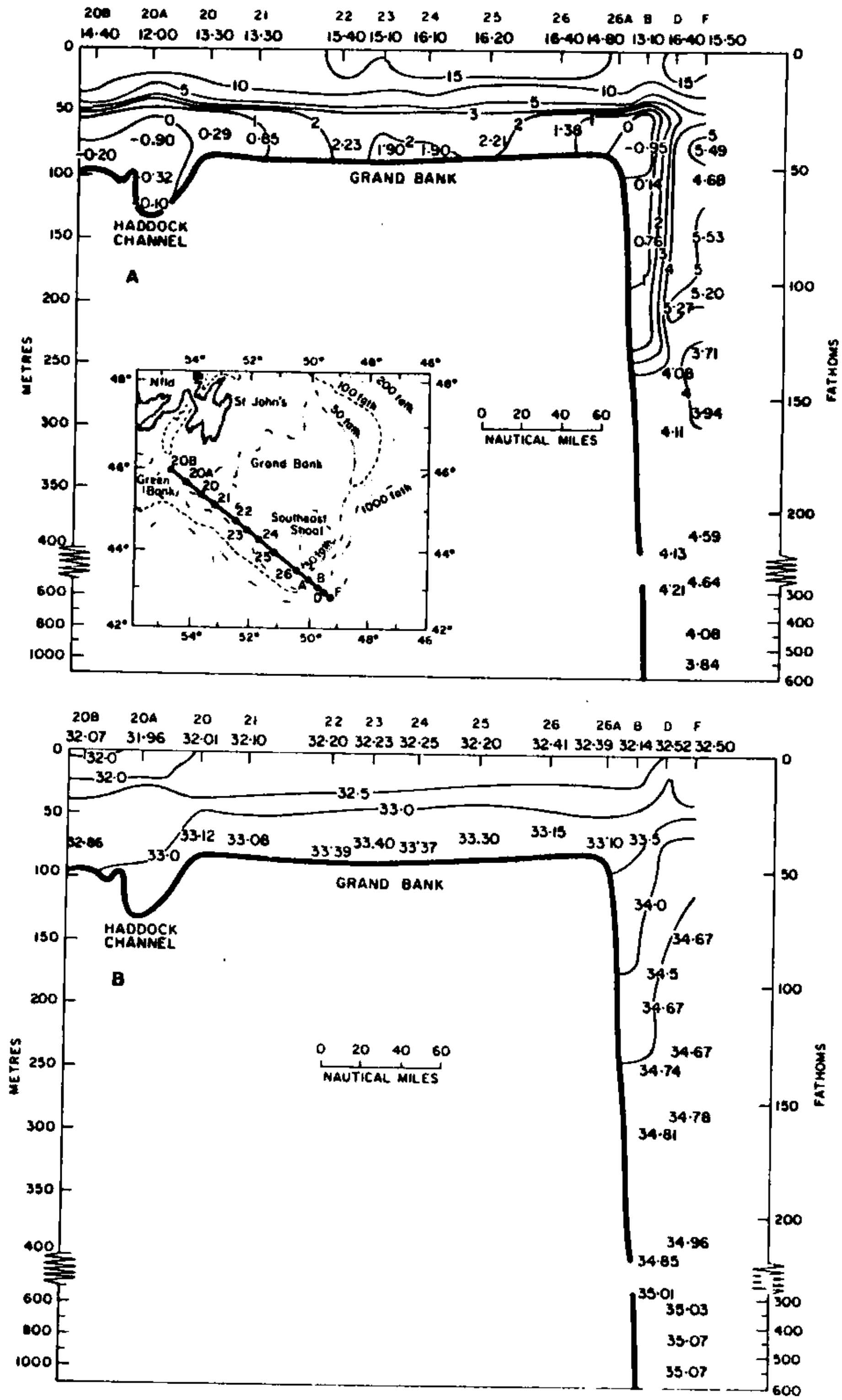

Fig. 5. Temperature (°C) above and salinity (‰) below, Green Bank-SE Grand Bank, 21-25 August 1969.

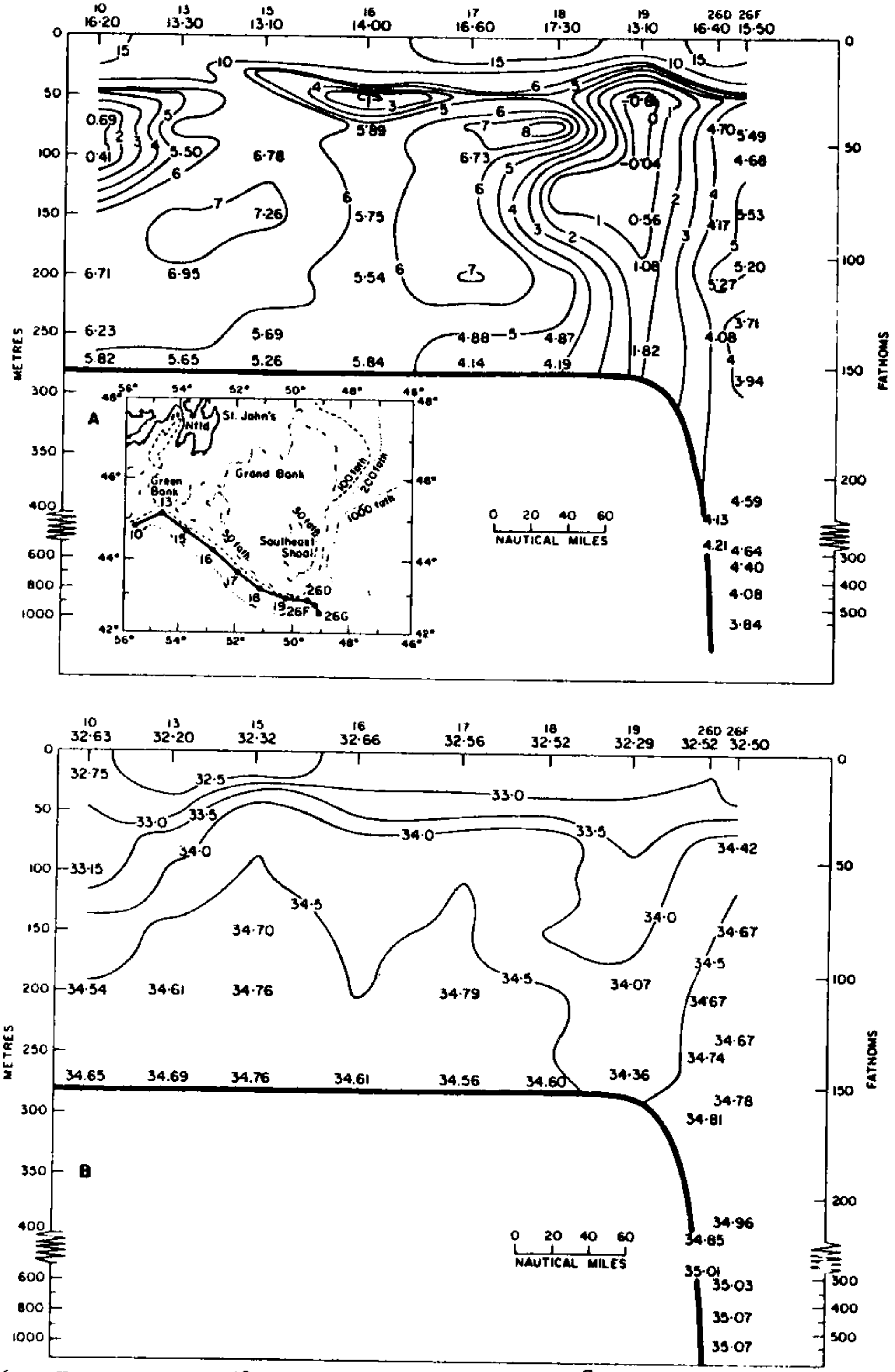

Fig. 6. Temperature (°C) above and salinity (°/oo) below, SW slope Grand Bank-St. Pierre Bank, 21-24 August 1969.

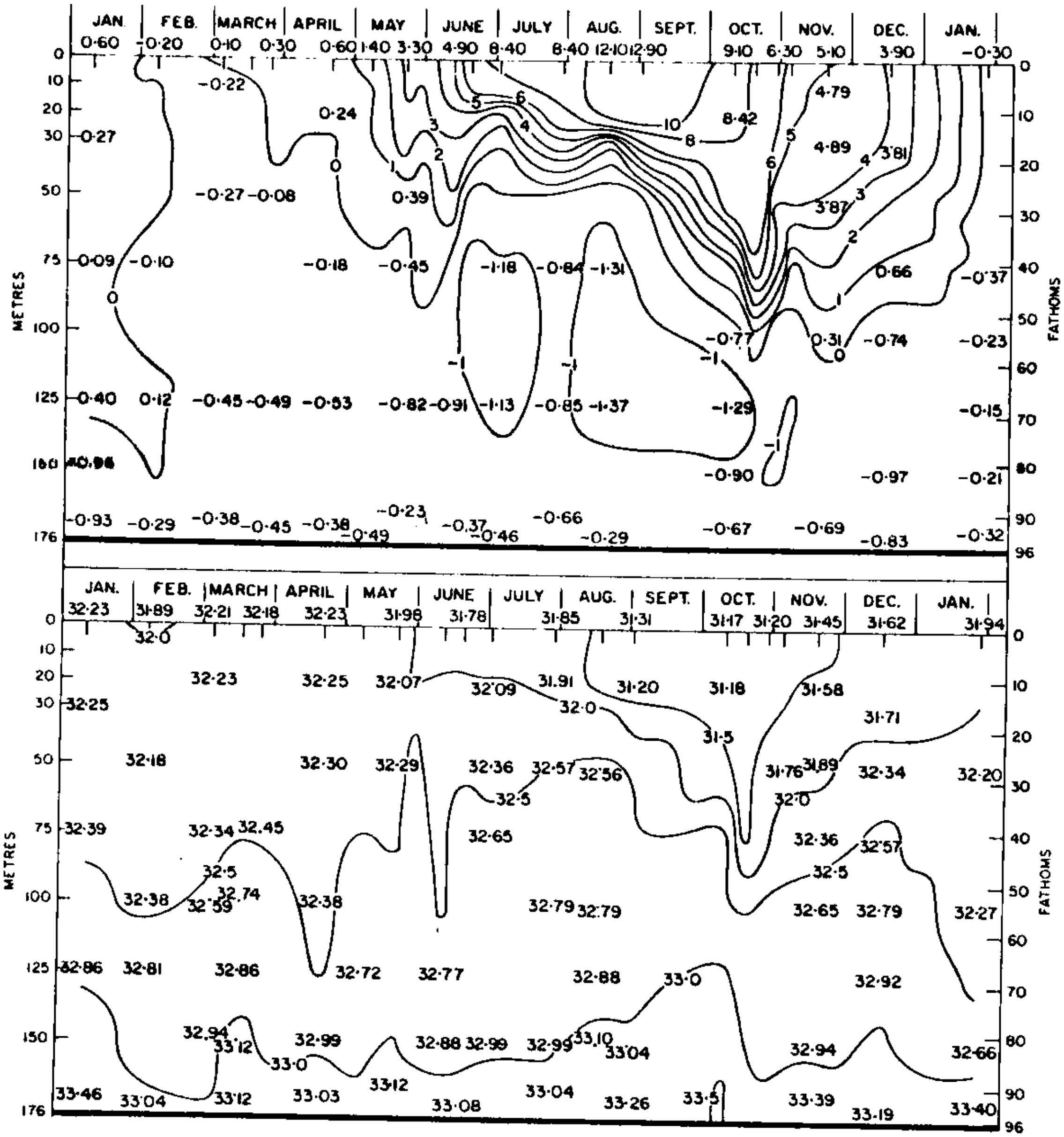

Fig. 7. Temperature (°C) above and salinity ($^{o}/oo$) below, January 1969 to January 1970, from surface to bottom at Station 27 (see Fig. 3, 4 inset), 2 nautical miles off Cape Spear near St. John's.

3. Annual Variations in Heat Content of the waters of the Northwestern Atlantic Shelf [1]

by V.P. Karaulovsky and I.K. Sigaev
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Introduction

The paper presents the results of an investigation of the annual variations in heat content of the waters of the Northwest Atlantic Ocean based on observations made by AtlantNIRO expeditions from 1962 to 1966. Generalization of the data collected on the heat content of the waters in the survey area is important in explaining some of the biological phenomena concerned with the abundance variability and composition of plankton as well as with the spawning conditions of individual commercial fishes. It can help to discover the relationship between the variations and trends in the heat content of waters and the variability of commercial stocks during the same interval of time.

Material and methods

Observations on water temperatures in the Gulf of Maine, on the US shelf, Nova Scotian Shelf and on Georges Bank between 1962 and 1966 were used in these studies. The observations were made on standard sections and when scouting for fish. Thus, the investigations covered an extensive area of shelf waters including the Nova Scotian Shelf, Georges Bank and the southern part of the Gulf and US Shelf along 76°W. All observations were grouped by conventional squares of 20' latitude and 30' longitude (Fig.1). Average seasonal water temperatures were estimated from the observations within each square. These average values were referred to the centre of the squares. These values were considered to be true when made up from not less than two observations per square. From these data, charts of the seasonal distribution of mean water temperatures were drawn for the 0 m, 30 m, 50 m and bottom-200 m layers. The choice of these layers is connected with the fact that the first three are characterized by concentrations of plankton and ichthyoplankton while the bottom- 200 m layer is characterized by commercial concentrations of fishes. Seasons were classified in the following way: winter - January, February; spring - April, May; summer - July, August, September; autumn - October, November. Such a classification is conditioned by extremely irregular year-round observations.

Annual variations in heat content were plotted as the deviations of observed water temperatures from the average seasonal temperatures and were derived from the formula:

where Δt - deviation of temperature
T - observed temperature
$\bar{T}$ - average seasonal temperature

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Charts of the distribution of seasonal and annual water temperature anomalies were made for the above-mentioned layers by plotting the deviations found. As a result, 15 charts of the distribution of the average seasonal temperatures were produced. Because of a lack of observations, only one chart of winter temperature anomalies was drawn for the 0 m layer. An additional 71 charts of the distribution of water temperature anomalies were drawn. The charts are too numerous to refer to in this paper.

The analysis of annual variability was made using the formula:

$$Q = 0.1cHt^{o}w,$$

where Q - amount of heat in the water layer (kg-cal.)
c - specific heat capacity of water
H - thickness of the water layer (m)
$t^{o}w$ - temperature of the water layer (°C)

Assuming the thickness of the water layer to be 1 m and the water temperature anomalies to characterize the variation of the amount of heat in the water layer, then $\Delta Q \approx c \, \Delta t^{o}w$,

where ΔQ - the variation in the amount of heat in 1 m water layer.
$\Delta t^{o}w$ - water temperature anomaly.

Charts of anomalies were summarized for four geographical zones designated in the following way:

Nova Scotian Shelf - I
Gulf of Maine - II
Georges Bank - III
US Shelf up to 70°W - IV

As each season is not equally provided by the data by seasons, it is impossible to make a strict quantitative analysis of these data. The following gradations are used to reveal the character of annual variability in heat content of waters according to the charts of temperature anomalies.

Anomalies	Sign
> + 2°C	+ +
from 0.5 to 2°C	+
from -0.5 to +0.5°C	0
from -0.5 to -2°C	-
> - 2°C	- -

Table 1A shows the degree of variability of the heat content of the water by geographic area, by season and by water layer for each year between 1962 and 1966. Table 1B shows the variability of heat content for the four geographic areas combined. Table 1C shows this variability by all the layers combined. Figures 2 and 3 show curves plotted from the data of Table 1.

Results of the analysis

The results of the investigations show that the greatest variability was recorded in the surface layer in the Gulf of Maine and on the Nova Scotian Shelf (Fig.2a). The curves of annual variability for these two areas show good agreement in phase and magnitude. At the end of 1962 and 1963 and at the beginning of 1964 the anomalies were positive in these areas and reached 4°C in some locations. In the summer of 1963 and 1965 the anomalies were negative with a peak of -1.5°C. Curves are rather smooth for Georges Bank and the US Shelf, and fluctuations are noted within ± 2°C. This difference between two areas can be explained by their geographical position. The surface waters in the Gulf of Maine and in the area of the Nova Scotian Shelf which are adjacent to the northern part of the continent are more strongly influenced by the intrusion of the continental air-masses than are the surface waters of Georges Bank and the US Shelf which are more southerly and are constantly influenced by the waters of the Gulf Stream.

The maximum temperature anomalies on Georges Bank were opposite to the maximum anomalies on the US Shelf during the whole period investigated (Fig.2).

At 30 m, the trend of water temperature anomalies was rather chaotic, but in 1962, 1963 and early in 1964 positive anomalies were recorded over almost the whole area. Since the last half of 1964 the anomalies have been negative, and only in the winter of 1965 were the anomalies positive being up to 1.3°C on Georges Bank and in the Gulf of Maine (Fig.2b).

These changes in heat content are in a good agreement with results obtained by Chase (1967), Colton (1968), Lauzier (1965a) and Sigaev (1969).

In the 50 m layer fluctuations of water temperature anomalies were, on the average, not greater than ± 2°C during all five years. The trends for the US Shelf, the Gulf of Maine and the Nova Scotian Shelf were analogous to that for the 30 m layer and confirm the occurrence of cooling after 1963. Simultaneously, the trend for Georges Bank is almost of sinusoidal character which can probably be explained by frequent variations in the inflow of waters of Gulf Stream and Labrador origin (Fig.2c).

The curve of water temperature anomalies for the bottom- 200 m layer is much like that for the 30m and 50m layers (cooling after 1963). On Georges Bank and in the Gulf of Maine, however, positive anomalies up to 1°C were recorded in the off-bottom layer in winter and spring of 1965. This is probably due to the intrusion of water masses from the Gulf Stream and of their distribution in the near-bottom layer in the Gulf (Fig. 2d).

The whole area is characterized by cooling which occurred after 1964 (Fig. 3a). The curve for the 0 m layer is almost sinusoidal due to the atmospheric processes influencing this layer. The curves for the 30 m and 50 m layers show cooling evident after 1964. In contrast to this fact, Lauzier (1965) pointed to a warming process in the 30 m layer in the summer of 1964 (positive anomalies up to 1.5°C). In addition, in the winter of 1966 in the bottom- 200 m layer a positive anomaly up to 3°C is recorded over the whole survey area. This may be due to the scanty winter data from Georges Bank and the Gulf of Maine (Fig.2d and 3d).

Since 1964 a cooling trend has been observed over the whole survey area (Fig. 3b and 3c).

Thus, in spite of episodic and scanty observations, the analysis shows that the data obtained are adequate to reveal thermic variability of shelf waters of the area, and to show a relative cooling recorded after 1964 and still observed in 1966.

Discussion

This paper is devoted to investigation of annual variability of the heat content of shelf waters in one of the major fishing grounds in the Atlantic Ocean. The work of most other investigators is based on multi-year water temperature observations at coastal stations and lightships (Chase, 1967; Lauzier, 1965a; Welch, 1967). Results of these investigations indicate cooling from the 1950's to date. Recent studies include water temperature data collected during sporadic surveys in several locations on the Northwestern Atlantic Shelf. These data give a good picture of the character of variability in the heat content of the waters in the areas in particular seasons (Colton, 1968) and over a period of several years (Sigaev, 1969). An attempt is made in this study to combine all available data on water temperature over a wide expanse of the shelf and based on their qualitative analysis to trace the character of the annual variability of seasonal heat fields over the shelf area. It is evident from the results that our methods are quite adequate for the analysis of multi-year variability of the heat content of the waters. The results show good agreement with the conclusions in the above-mentioned papers. Some discrepancies can be attributed to the various methods of the analysis, to scanty observations or to the lack of observations in individual areas and seasons.

The observed cooling of shelf waters could have a direct influence (e.g. on survival of fish eggs and larvae) or indirect one (e.g. on food availability) upon variations in the abundance of some commercial species. For instance, a decrease in abundance of silver hake has been recorded from the Nova Scotian Shelf since 1964 (Konstantinov and Noskov, 1965), but for Georges Bank and the Gulf of Maine it has been noted from 1962 to date (Konstantinov and Noskov, 1966). Simultaneously, an increase in abundance of such species as yellowtail flounder has been observed (Edwards, 1968).

In addition, the reduction in abundance of silver hake during the period 1962-1966 is supported by preliminary results obtained by A.S. Noskov when comparing the distribution of this species during the warm (1962-64) and cold (1964-66) water periods.

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A

year	LEVEL 0 M winter I	winter II	winter III	winter IV	spring I	spring II	spring III	spring IV	summer I	summer II	summer III	summer IV	fall I	fall II	fall III	fall IV
1962									– –	o	–	+ +	– –	–	– –	
1963	+	+			+ +		+	– –	+	+ +	o	– –	–	+	–	+
1964	–	o			–	– –	o	–	–	o	+	o	+ +	+ +	– –	+
1965					–	+	–	–	o	o	–	+	–	+	+	– –
1966	–	–			– –	–	–	o	+	+	+	o	+	+	o	–

year	LEVEL 30 M winter I	winter II	winter III	winter IV	spring I	spring II	spring III	spring IV	summer I	summer II	summer III	summer IV	fall I	fall II	fall III	fall IV
1962					o		+	+	– –	+	–	+ +	–	–	– –	
1963	+	+			+	+	+ +	–	o	o	–	+ +	o	+	o	+
1964	–	o			–	o	o	o	+ +	o	+	–	+	+	– –	o
1965					o	o	–	–	o	o	o	–	o	+	+	– –
1966	–	–			o	–	–	o	o	– –	+	–	o	o	+	o

year	LEVEL 50 M winter I	winter II	winter III	winter IV	spring I	spring II	spring III	spring IV	summer I	summer II	summer III	summer IV	fall I	fall II	fall III	fall IV
1962					+	o	+	+ +	+	+	–	+ +	+	+	–	
1963	+	+			+	+	+	o	o	+	–	+ +	o	+	+	o
1964	–	–			o	+	o	o	o	–	+	–	–	o	–	o
1965					o	–	–	–	o	–	+	– –	+	–	+	–
1966	+	+			o	–	–	–	o	–	+ +	–	–	o	+	o

year	LEVEL 200 M - BOTTOM winter I	winter II	winter III	winter IV	spring I	spring II	spring III	spring IV	summer I	summer II	summer III	summer IV	fall I	fall II	fall III	fall IV
1962					o	o	+	+ +	+	+	–	+	+	+	–	
1963	o	o			+	+	+	+	o	+	+	+ +	o	+	o	+ +
1964	o	–			o	+	o	o	+	–	o	–	o	–	–	o
1965					o	o	–	o	o	–	+	–	o	–	+ +	–
1966	o	+ +			–	o	–	o	o	–	o	o	–	–	+	–

B

LEVEL 0 M year	winter	spring	summer	fall	year
1962			o (–)	– –	–
1963	+	+	o (+)	o	+
1964	–	– –	o	+ (+)	–
1965		–	o	o (–)	–
1966	–	– –	+	o (+)	–

LEVEL 30 M year	winter	spring	summer	fall	year
1962		+	o	–	o
1963	+	+ +	+	+	+ (+)
1964	–	– (o)	+	o	o
1965		–	o (–)	o	– (o)
1966	–	–	–	o (+)	–

LEVEL 50 M year	winter	spring	summer	fall	year
1962		+ +	+ (+)	+	+ (+)
1963	+	+	+ (+)	+	+
1964	–	+ (o)	o (–)	–	–
1965		–	–	o	–
1966	+	–	o	o	o

LEVEL 200 M - BOTTOM year	winter	spring	summer	fall	year
1962		+ +	+	+	+ (+)
1963	o	+	+	+	+
1964	–	+ (o)	o (–)	–	–
1965		– (o)	o (–)	o	–
1966	+ (+)	–	o	–	o

year	winter	spring	summer	fall	year
1962		+ +	+	– (o)	+ (+)
1963	+	+	+	+	+
1964	–	o (–)	o	o (–)	o (–)
1965		–	–	o	–
1966	o	–	o	o	o (–)

C

Table 1. Qualitative evaluation of the heat content of the waters of the Northwest Atlantic in 1962-66.

A. for the 0 m, 30 m, 50 m and bottom- 200 m layers by season and geographic areas.

B. for the 0 m, 30 m, 50 m and bottom- 200 m layers by seasons for all areas.

C. for all layers combined, by season.

(Symbol in parenthesis in B and C indicate the tendency to reach the values shown in the parenthesis).

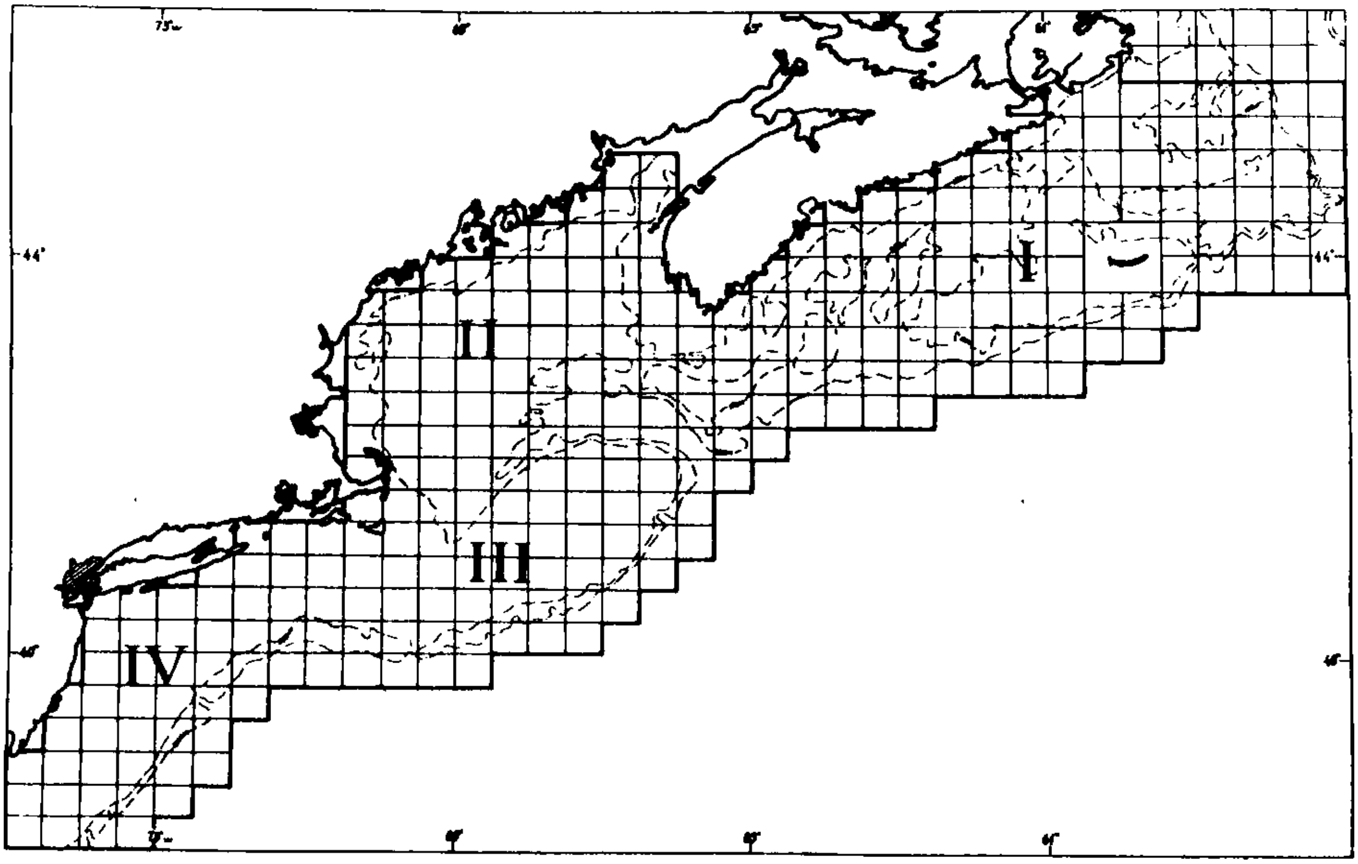

Fig. 1. Showing the areas of investigation divided into squares of 20' lat. and 30' long.

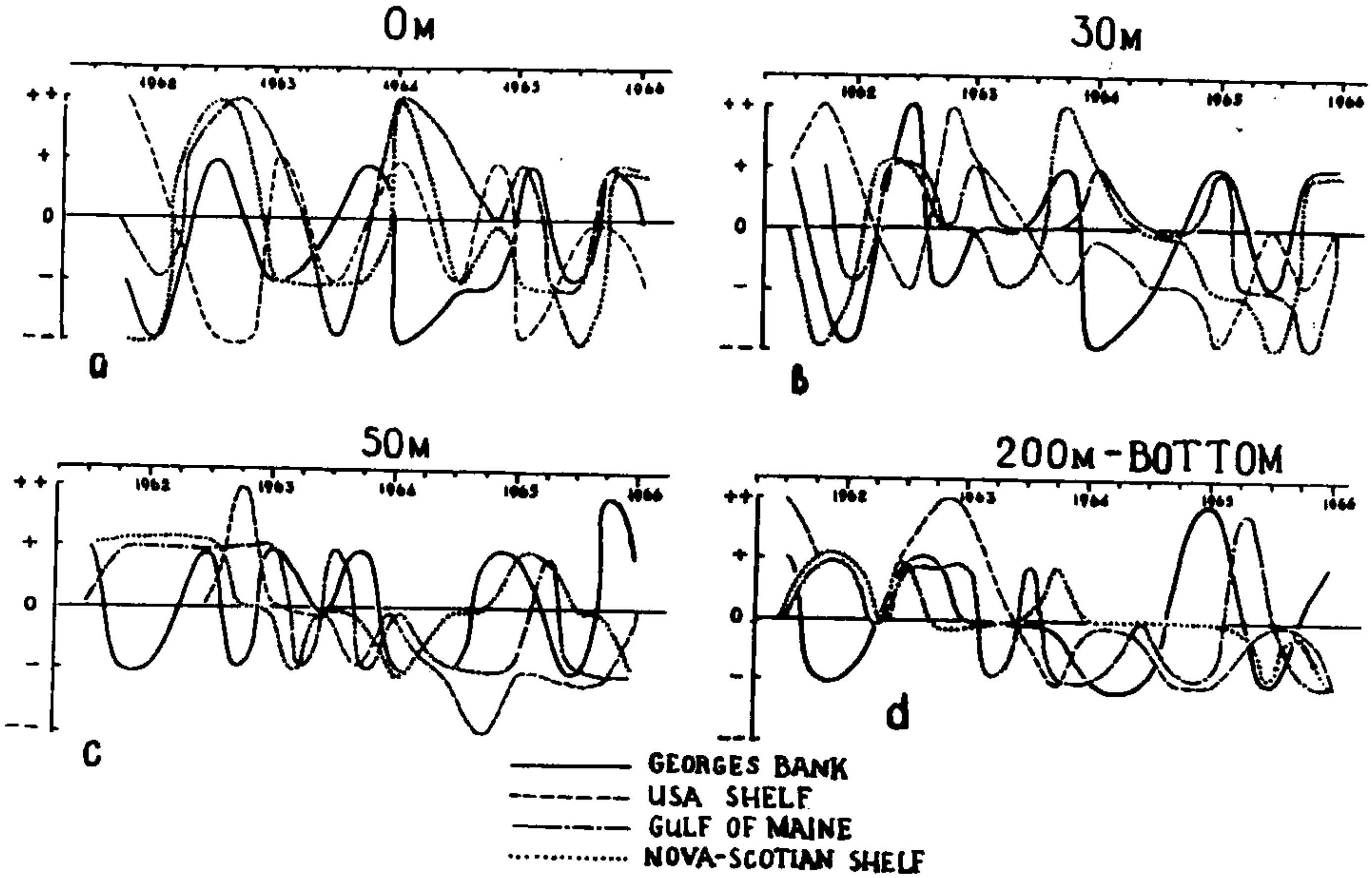

Fig. 2. Variability in heat content in the waters of the Northwestern Atlantic 1962-66. a. the 0-m layer
b. the 30-m layer
c. the 50-m layer
d. the 200-m - bottom layer

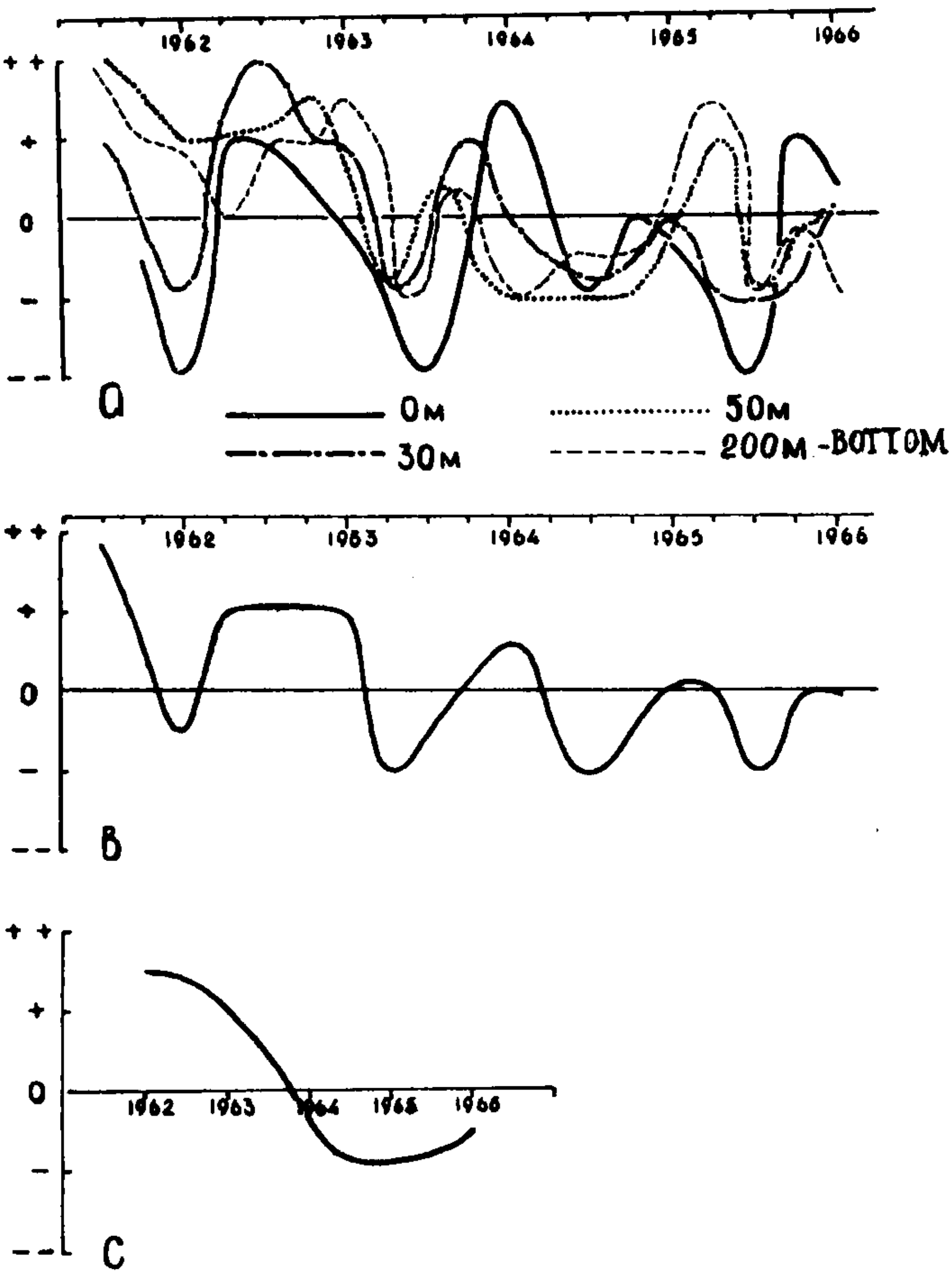

Fig. 3. Trends in the heat content of the waters of the Northwestern Atlantic 1962-66.
a. for the 0-m, 30-m, 50-m and 200 m - bottom water layers.
b. for all layers combined.
c. smoothed to show trend.

4. Comparison of 1968 and 1969 Temperature Conditions in the Gulf of Maine and Adjacent Waters [1]

by John B. Colton, Jr.[2] and Walter R.Welch[3]

Surface temperatures at Boothbay Harbor, Maine, have proved to be a good index to offshore surface and subsurface temperature conditions in the Gulf of Maine and contiguous waters (Colton 1968a, 1968b, and 1969). The monthly mean temperatures at Boothbay Harbor were higher in 1969 than in 1968 in all months except September and December (Fig. 1). Positive anomalies (1969 minus 1968) of 1.0°C or greater occurred in January, February, March, June, and November. The 1969 annual mean temperature was 0.8°C higher than in 1968.

The only temperature data available for offshore comparisons are from BT observations taken on the annual fall groundfish surveys (*Albatross IV* Cruise 68-7, 10 October - 25 November, 1968 and *Albatross IV* Cruise 69-11, 8 October - 23 November, 1969). Although there was a considerable time-period required to cover the area as a whole, most 60-minute quadrangle areas were sampled at roughly the same time (± week) each year. Anomalies were computed as the difference between the 1969 and 1968 mean temperatures within 30-minute quadrangle areas at depths of 1, 50, and 100 m. During a given cruise the number of temperature observations within 30-minute quadrangle areas ranged from one to six, but in most quadrangles there were at least two observations each year.

Surface temperatures (Fig. 2) were higher in 1969 over the central Gulf of Maine, along the coast from Grand Manan to Portland, and east of Cape Cod. Temperatures were also higher in the South Channel area, over Georges Shoals and the southeast part of Georges Bank, and along the edge of the Continental Shelf south of Nantucket Shoals. In all other areas the temperatures were lower in 1969 than in 1968. The greatest positive anomalies occurred over the south central Gulf of Maine and the greatest negative anomalies in the mouth of the Northeast Channel and along the southern edge of Georges Bank between Lydonia and Veatch Canyons.

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[1] submitted to the 1970 Annual Meeting of ICNAF as ICNAF Res. Doc.70/59.

[2] Bureau of Commercial Fisheries Biological Laboratory, Woods Hole, Mass. 02543, USA.

[3] Bureau of Commercial Fisheries Biological Laboratory, Boothbay Harbor, Maine, 04575, USA.

Temperatures at 50 m (Fig. 3) were higher in 1969 in the south central Gulf of Maine and off southeastern Nova Scotia (Roseway and LaHave Banks). In all other areas temperatures were lower in 1969 than in 1968. The negative anomalies were greatest south of Browns and Georges Banks and increased with distance from shore. At 100 m (Fig.4) 1969 temperatures were also higher in the south central Gulf of Maine with the highest values occurring over the Wilkinson Basin area. In all other areas the anomalies were negative.

Valid predictions cannot be made on a basis of such limited data for as illustrated in the 1968 and 1969 seasonal temperature curves for Boothbay Harbor, temperature conditions for a specific month are not always indicative of the annual trend. However, Colton (1968b and 1969) has shown that the long-term warming and cooling trends of both surface and subsurface waters in the Gulf of Maine depend in large measure on the relative position and degree of mixing of coastal and oceanic water masses. Cold years occur when Slope Water is displaced or modified by Coastal Water of Labrador origin. The negative subsurface anomalies in the Northeast Channel area and along the edge of the Continental Shelf during October - November 1969 may have been associated with a change in the composition of the subsurface water resulting from an incursion of Labrador Coastal Water. If in fact there was a shift in the relative position and degree of mixing of Slope Water and Labrador Coastal Water, this could be indicative of a check or reversal in the upward trend in coastal and offshore sea water temperatures which commenced in 1968. We shall continue to monitor hydrographic conditions in critical areas along the Continental Slope to determine if the negative temperature anomalies observed during 1969 were due to a major change in the composition of the subsurface water.

References

Colton, J.B., Jr., 1968a. A comparison of current and long-term temperatures of Continental Shelf waters, Nova Scotia to Long Island. *Res.Bull. int. Comm. Northw. Atlant. Fish.*, No.5: 110-129.

1968b. Recent trends in subsurface temperatures in the Gulf of Maine and contiguous waters. *J. Fish. Res. Bd. Canada* 25: 2427-2437.

1969. Temperature conditions in the Gulf of Maine and adjacent waters during 1968. *J. Fish. Res. Bd. Canada* 26: 2746-2751.

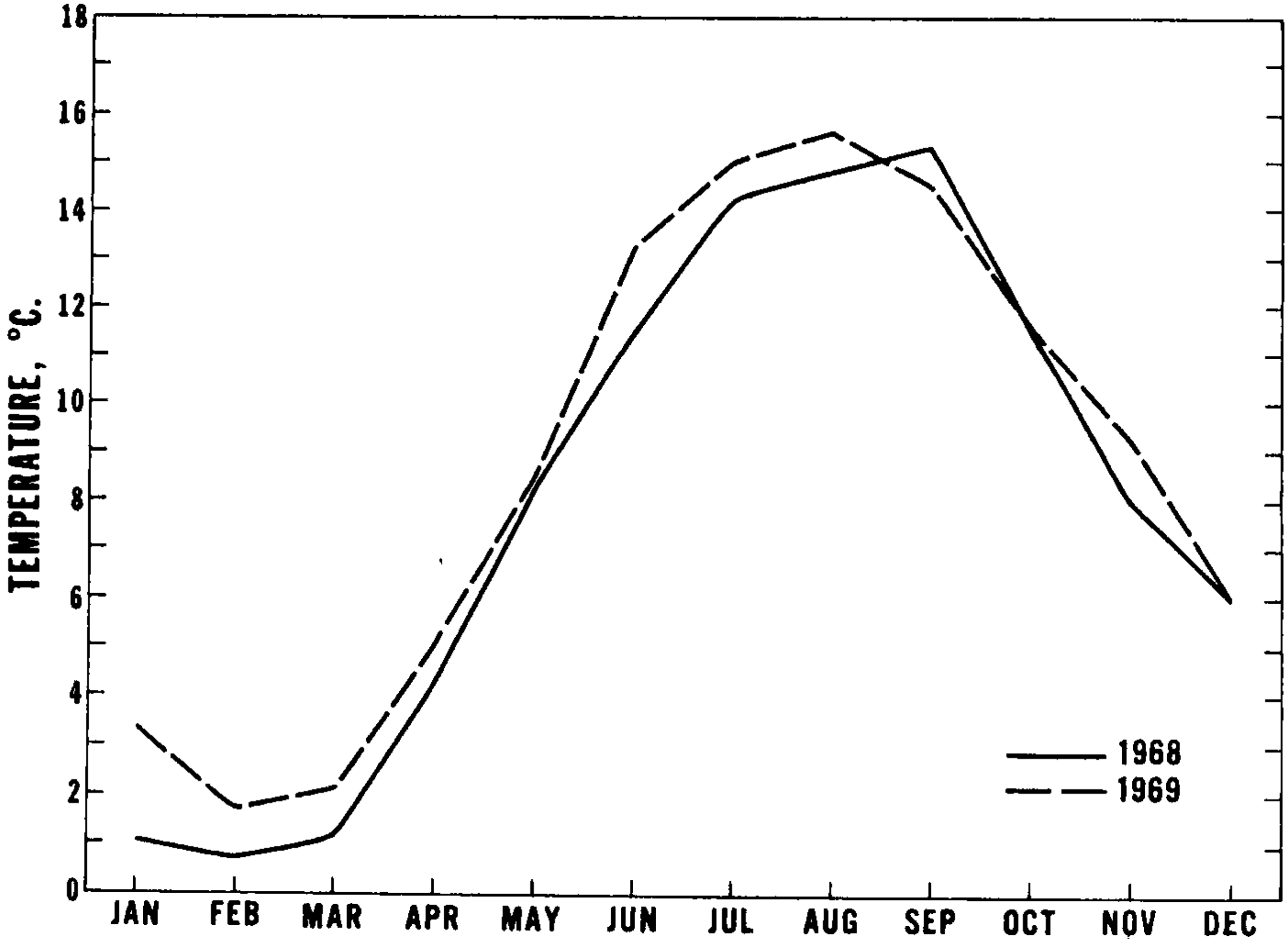

Fig. 1. Seasonal temperature curves, Boothbay Harbor, Maine, 1968 and 1969.

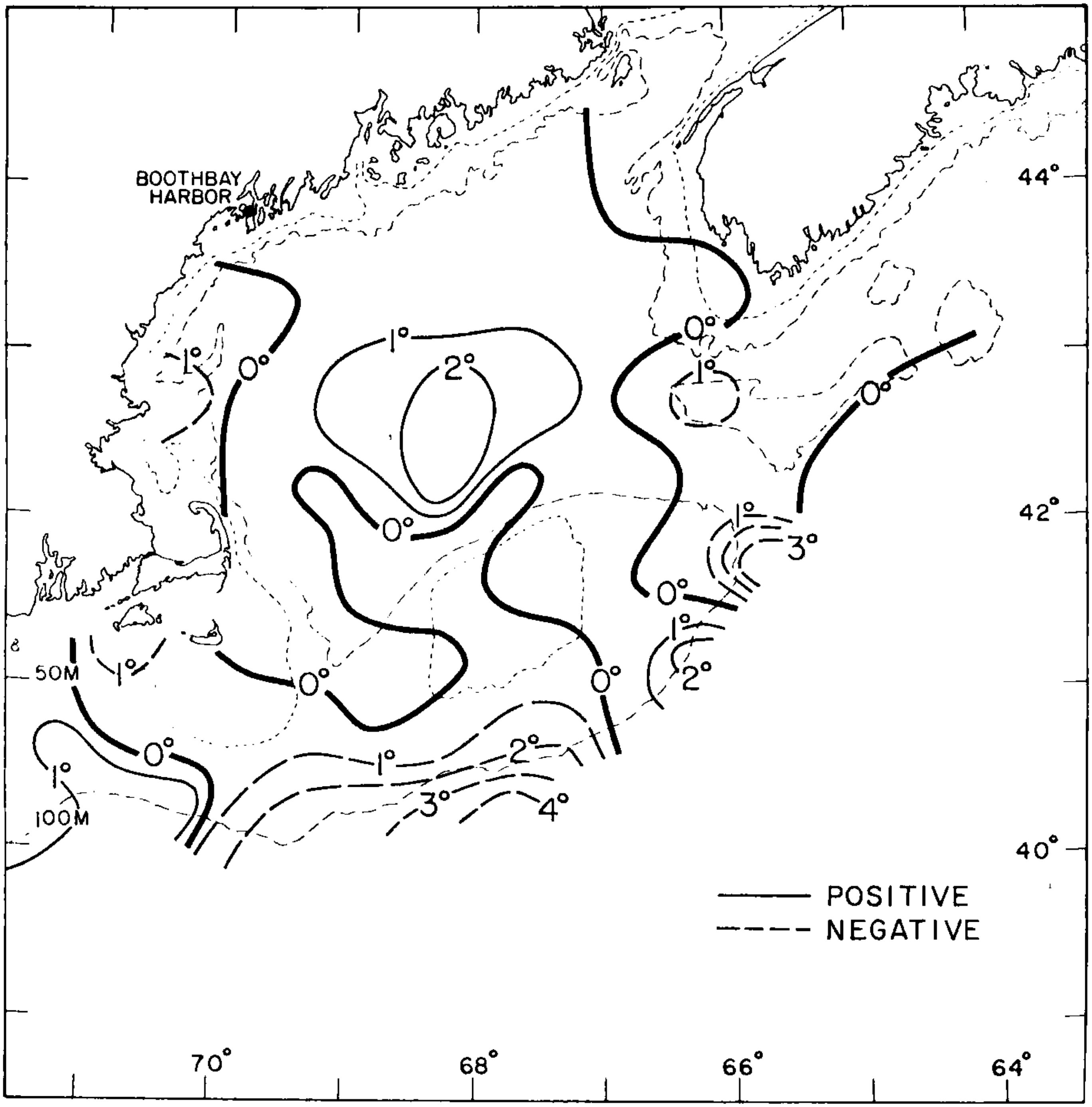

Fig. 2. Temperature anomalies at the surface during October - November 1969 relative to October - November 1968.

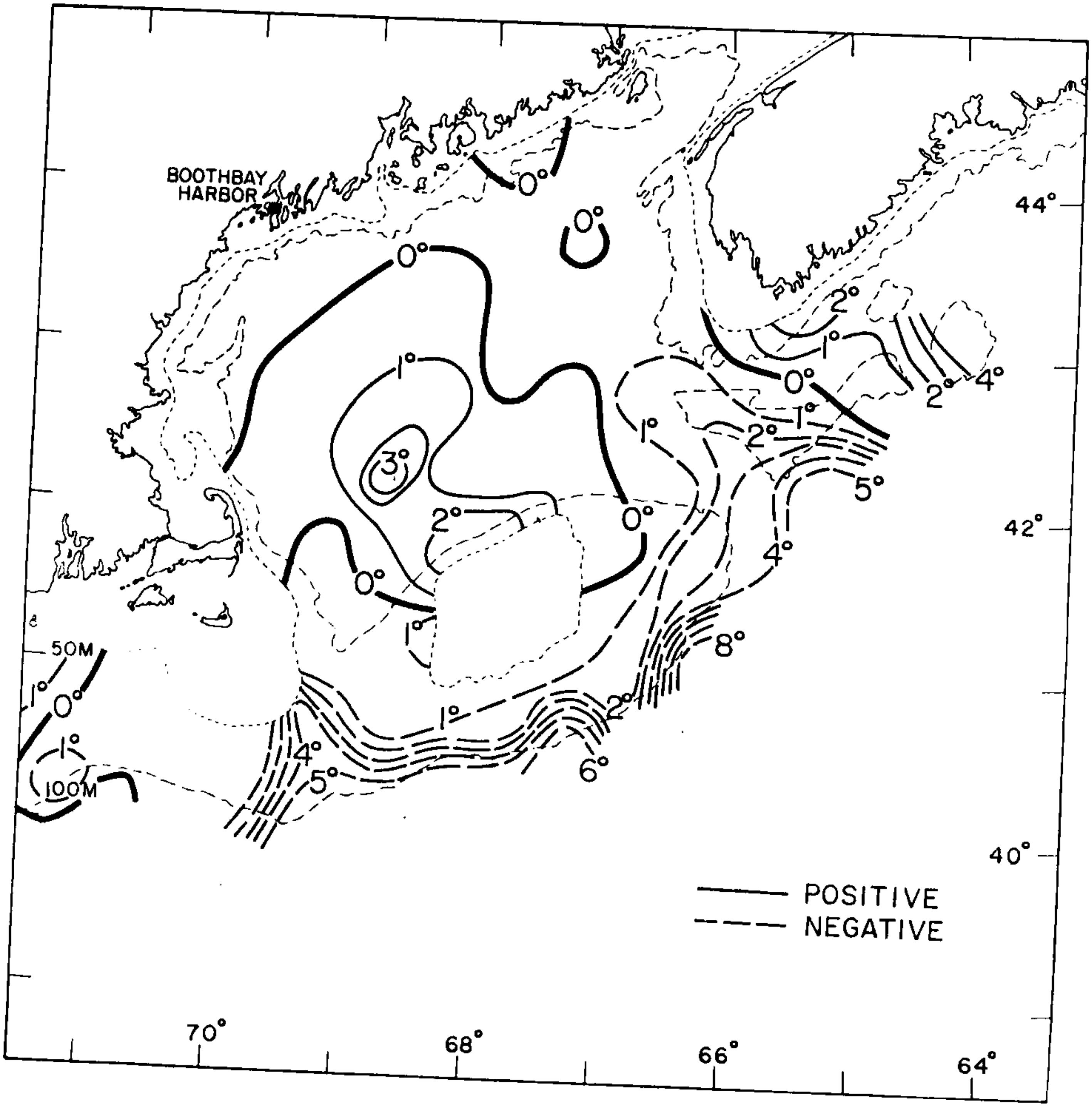

Fig. 3. Temperature anomalies at 50 m during October - November 1969 relative to October-November 1968.

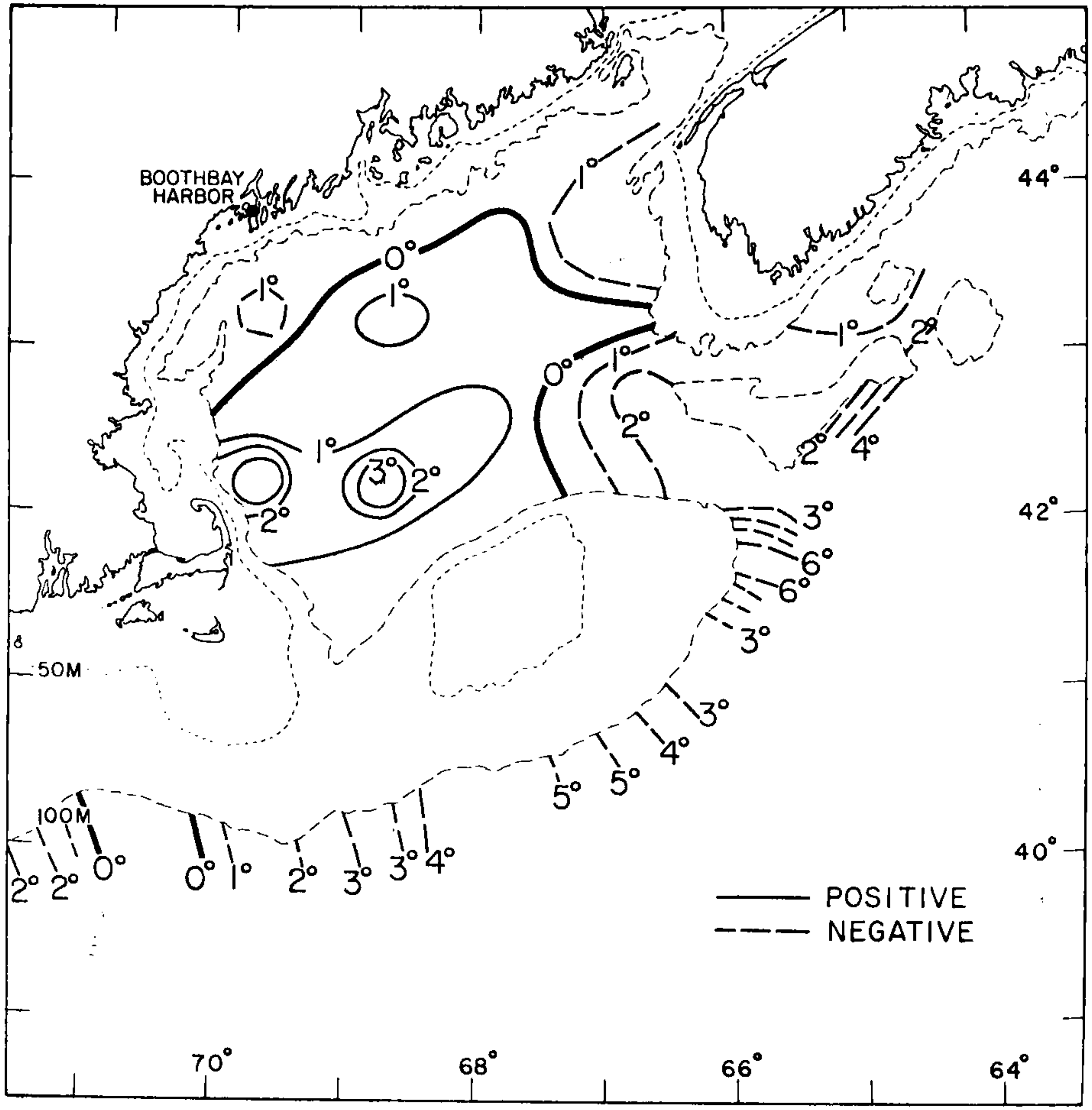

Fig. 4. Temperature anomalies at 100 m during October - November 1969 relative to October - November 1968.

5. Hydrographic Observations in Subareas 2-5 in 1969[1]

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Bremerhaven, Fed. Rep. Germany

Introduction

During two cruises of R/V *Walther Herwig* in the ICNAF Area several temperature and salinity sections and additional bathythermograph (BT) stations were occupied in Subareas 2, 3, 4, and 5 in January, February and again in October-November 1969. As far as possible nearly the same sections were occupied on both cruises.

Observations were carried out only once in the Grand Bank - Flemish Cap area (Div. 30, L, M) in Feburary 1969. Because of severe ice conditions off Labrador at this time only a few hydrographic stations could be occupied off South Labrador and none off central or northern Labrador. But in late October 1969 one section off northern Labrador (Div. 2G) and one off southern Labrador (Div. 2J) were occupied across the Labrador Current.

Our gratitude and acknowledgement is due to Mr K. Wiedemann, hydrographic technician on both cruises, for taking most of the hydrographic observations and for providing most of the data for this paper.

Subarea 2 - Labrador

By the end of February 1969 the edge of the drift ice extended almost everywhere beyond the shelf off Labrador (Fig.1). Accordingly the hydrographic program had to be restricted to one very short section across the southeastern slope of Hamilton Inlet Bank (Div. 2J). Nevertheless the hydrographic situation as shown in Fig. 1 indicated that cold water masses of the Arctic component of the Labrador Current seemed to occupy the whole shelf area at least down to 200 m. On the slope of the Bank, bottom temperature in 400 m was below 3°C. In the surface layer down to 40 m Arctic water ($<$ - 1.75°C, $<$ 33.3‰) extended beyond the 1,000 m line. The highest temperature (4.18°C) and salinity (34.95‰) were observed off the slope (Station 7) in 510 m and 725 m respectively.

This hydrographic situation suggested that the dense cod concentrations fished successfully in the slope areas were possibly due to the very limited areas of optimal temperature conditions. But preliminary results of hydrographic observations in the same area in February 1970 did not confirm this suggestion.

A more complete picture of the hydrographic conditions off Labrador was obtained in late October 1969. A comparison of the sections off Cape Chidley (Div. 2G) (Fig. 2), and across Hamilton Inlet Bank (Div. 2J) on the same line as the Canadian standard section off Seal Islands (Fig. 3), shows

[1] submitted to the 1970 Annual Meeting of ICNAF as ICNAF Res.Doc.70/94.

that the warmer West Greenland component of the Labrador Current decreased on its way south somewhat in temperature and salinity but its core shoaled, so that water of 3-4°C reached the slope off South Labrador in depths about 100 m less than off northern Labrador. From February to October 1969, the warmer slope water of southern Labrador showed changes in its depth by about 150 m but not in its temperature and salinity (Fig. 1 and 3).

Compared to October 1967 (Redbook 1968, Part II, p.56 and Pt.III, p.27) water temperatures off Cape Chidley were quite similar in 1969, but the salinities were higher in the upper 200 m, while at Hamilton Inlet Bank only the offshore component showed similar values to 1967. Over the inshore part of the Bank the core of the cold water extended from 100 m to the bottom with minimum temperatures in Hawke Channel, which is rather unusual. Because of its heaviness this cold water might possibly remain there for a long time.

Subarea 3, - Newfoundland

The Canadian standard section across the Grand Bank at 47°N to Flemish Cap routinely occupied by the St. John's Station in summer was also occupied by R/V *Walther Herwig* in February 1969 (Fig. 4). Contrary to the extreme temperature stratification prevailing in summer, almost homogeneous temperatures around 0°C and salinities around 33.0°/oo from surface to bottom were observed over the Grand Bank. The inshore and offshore cores of the cold water component of the Labrador Current were only indicated by temperatures slightly below 0°C. On the eastern slope of the Bank bottom temperatures increased rather quickly from 1 to 3°C between 200 and 300 m. Again nearly homogeneous temperatures around 4°C were observed on Flemish Cap.

A further section (Fig. 5) from the southwestern slope of the Grand Bank northward to the inner station (105) of the section to Flemish Cap showed a similar uniformity of the hydrographic situation on the Bank.

Subarea 4

The sections worked across Cabot Strait between Cape Breton Island (Div.4Vn) and Burgeo Bank (Div. 3Ps) in February (Fig.6) and at the end of October (Fig. 7) show a very similar and apparently rather constant stratification of the water layers exceeding 100 m. A well developed more or less horizontal thermocline in about 150 m separated the deeper warm water of relatively high salinity occupying the whole Laurentian Channel from a cold layer above. In February this cold water occupied the whole upper layer to the surface and was coldest at the surface. According to further hydrographic and BT stations distributed along both sides of the Laurentian Channel as far southeast as the southeastern slope of Banquereau Bank (Div. 4Vs) and the southwestern slope of St. Pierre Bank (Div. 3Ps) respectively, surface temperatures increased gradually from about 0.1°C over the shelf off Cape Breton Island to about 2°C over the southeastern slope of Banquereau Bank, whereas they remained fairly stable around 1°C along the western slopes of

Burgeo and St. Pierre Bank. By the end of October the cold layer had become an intermediate layer due to the formation of a second thermocline separating it from a warm surface layer. At the same time, a herring fishery was carried out by German trawlers off Cape Breton Island.

A similar pattern of stratification is shown in the sections across Emerald Bank (Div. 4W) at corresponding times of the year. The temperatures involved here, however, were considerably higher (Fig. 8 and 11). Very warm (> 9°C) near-bottom water in the Emerald Basin occupied the whole shelf area in February as well as in November 1969.

Subarea 5

The two sections across the eastern part of Georges Bank (Div. 5Ze) show in January homogeneous temperatures of 5 to 6°C from surface to bottom over the Bank, but increasing rapidly to over 12°C at the southern slope (Fig. 9). In November temperatures to over 10°C from surface to bottom were found on top of the Bank, but cores of colder water around 6°C flank the northern as well as the southern slopes (Fig. 12). Almost the same temperature distribution, but slightly higher salinities were observed over the western part of the Bank early in the year (Fig. 10). In November the salinity distribution was almost the same over both parts of the Bank, whereas the temperatures on top of the western part were considerably higher, up to over 13°C (Fig. 13).

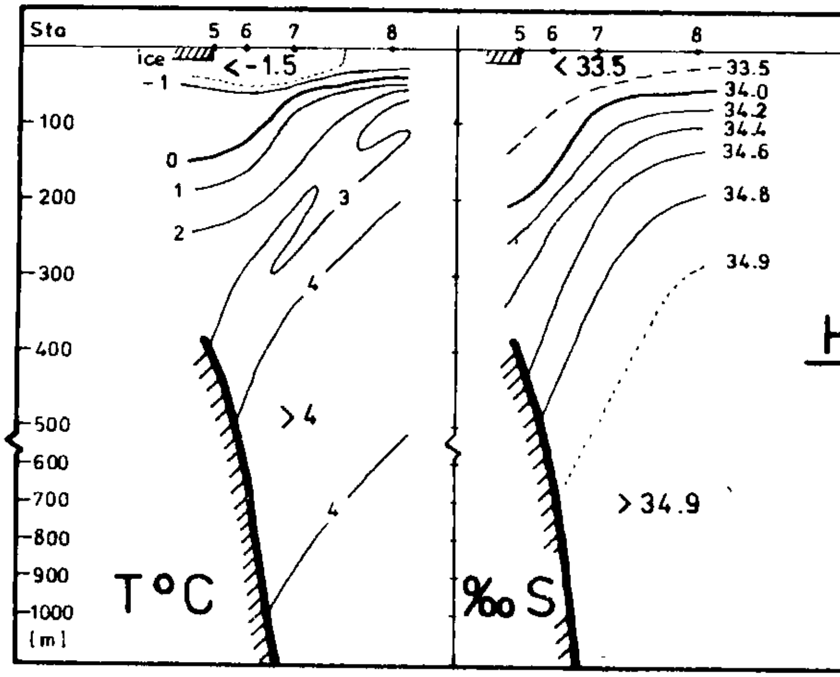

Fig. 1

Hamilton Bank

53° 52′ N ⟷ 54° 18′ N
52° 52′ W 52° 14′ W

25. II. 69

20 nm

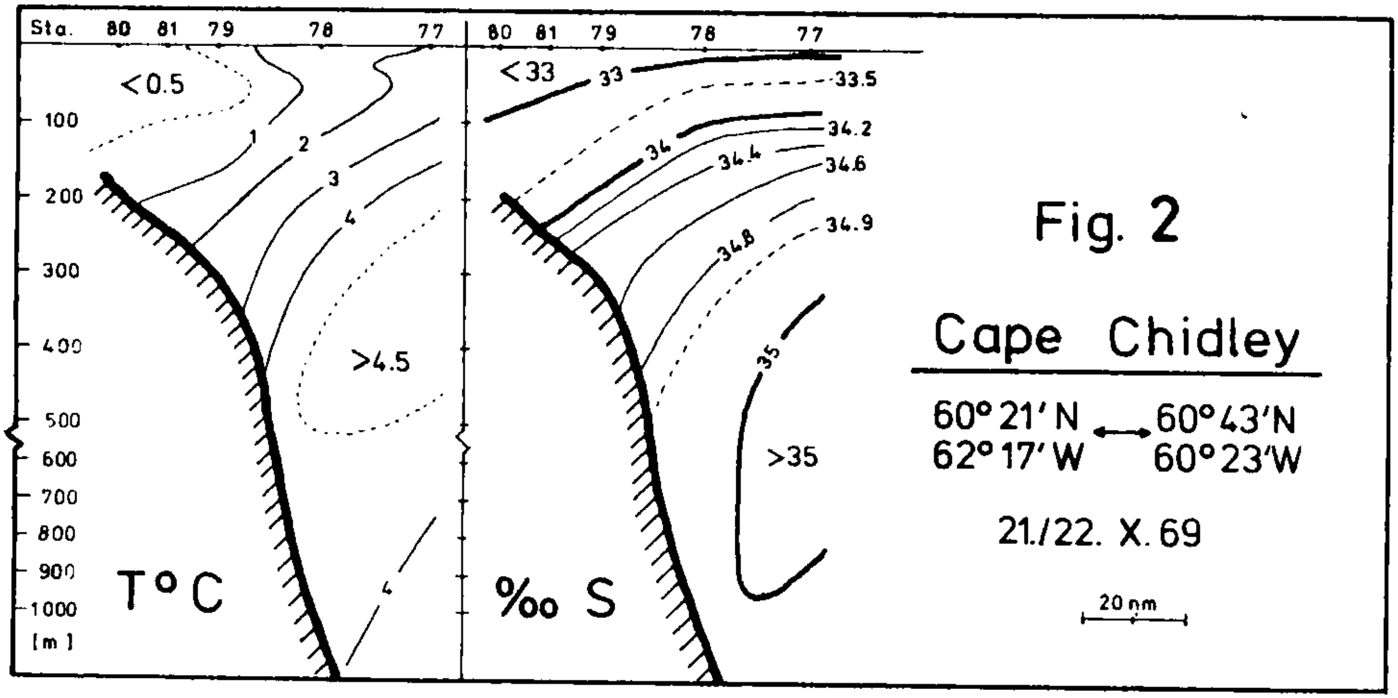

Fig. 2

Cape Chidley

60° 21′ N ⟷ 60°43′N
62° 17′ W 60°23′W

21./22. X. 69

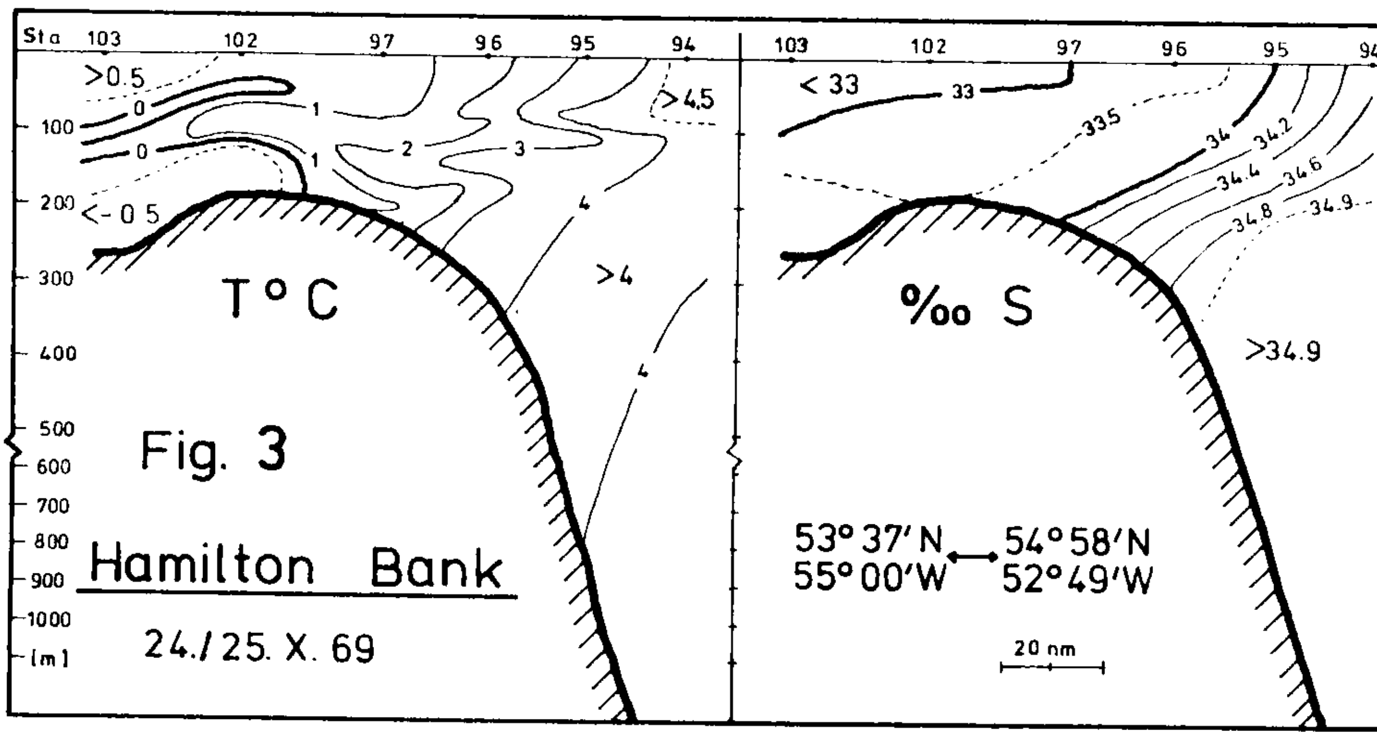

Fig. 3

Hamilton Bank

24./25. X. 69

53° 37′ N ⟷ 54° 58′ N
55° 00′ W 52° 49′ W

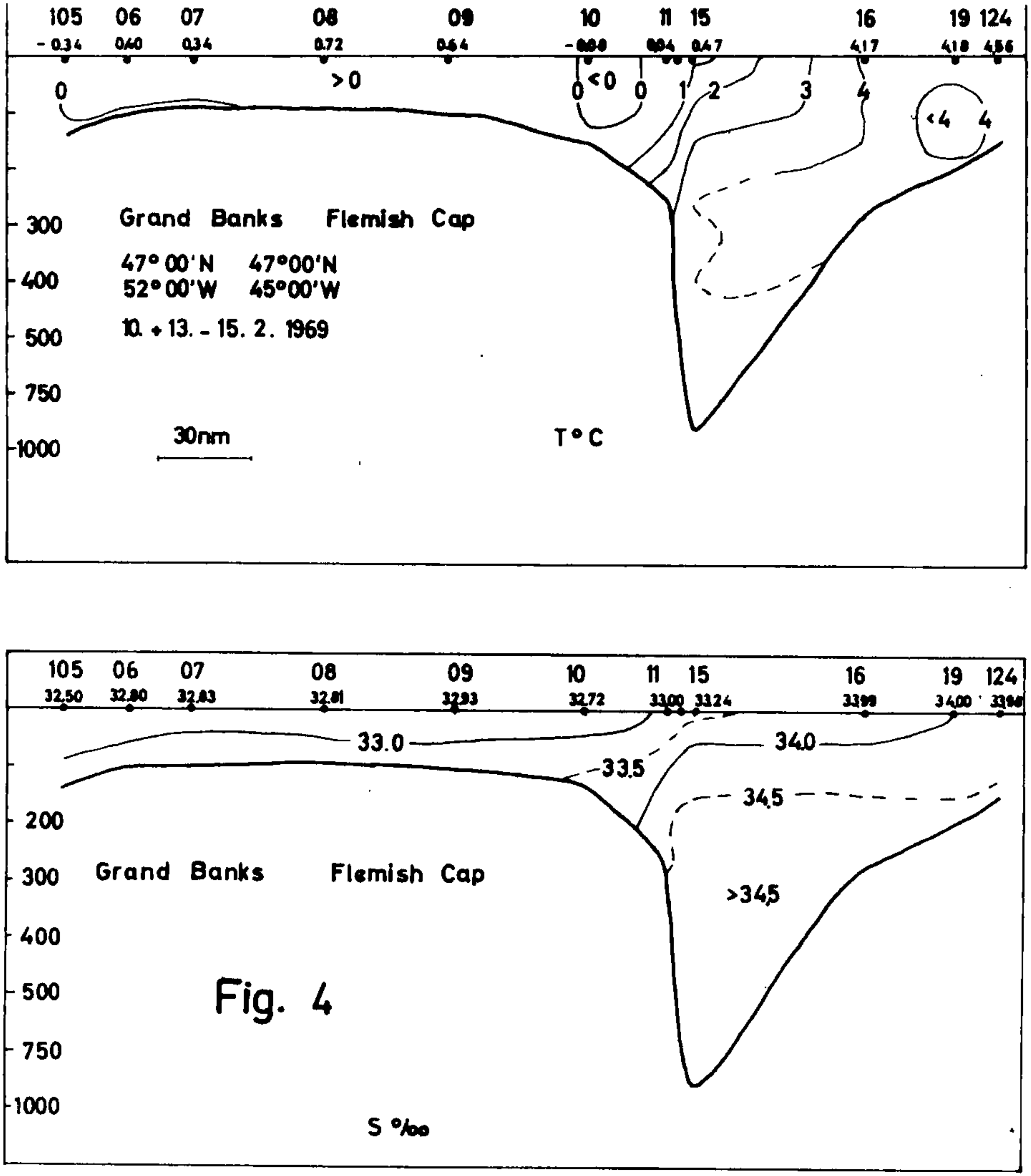
105 06 07 08 09 10 11 15 16 19 124
-0.34 0.40 0.34 0.72 0.64 0.47 4.17 4.18 4.56
0
>0
0 <0 0 1 2 3 4
<4 4
300
400
500
750
1000
Grand Banks Flemish Cap
47° 00'N 47°00'N
52° 00'W 45°00'W
10. + 13. - 15. 2. 1969
30nm
T ° C
105 06 07 08 09 10 11 15 16 19 124
32.50 32.80 32.83 32.81 32.93 32.72 33.00 33.24 33.99 34.00
33.0
34.0
33.5
34.5
>34.5
200
300
400
500
750
1000
Grand Banks Flemish Cap
S ‰

Fig. 4

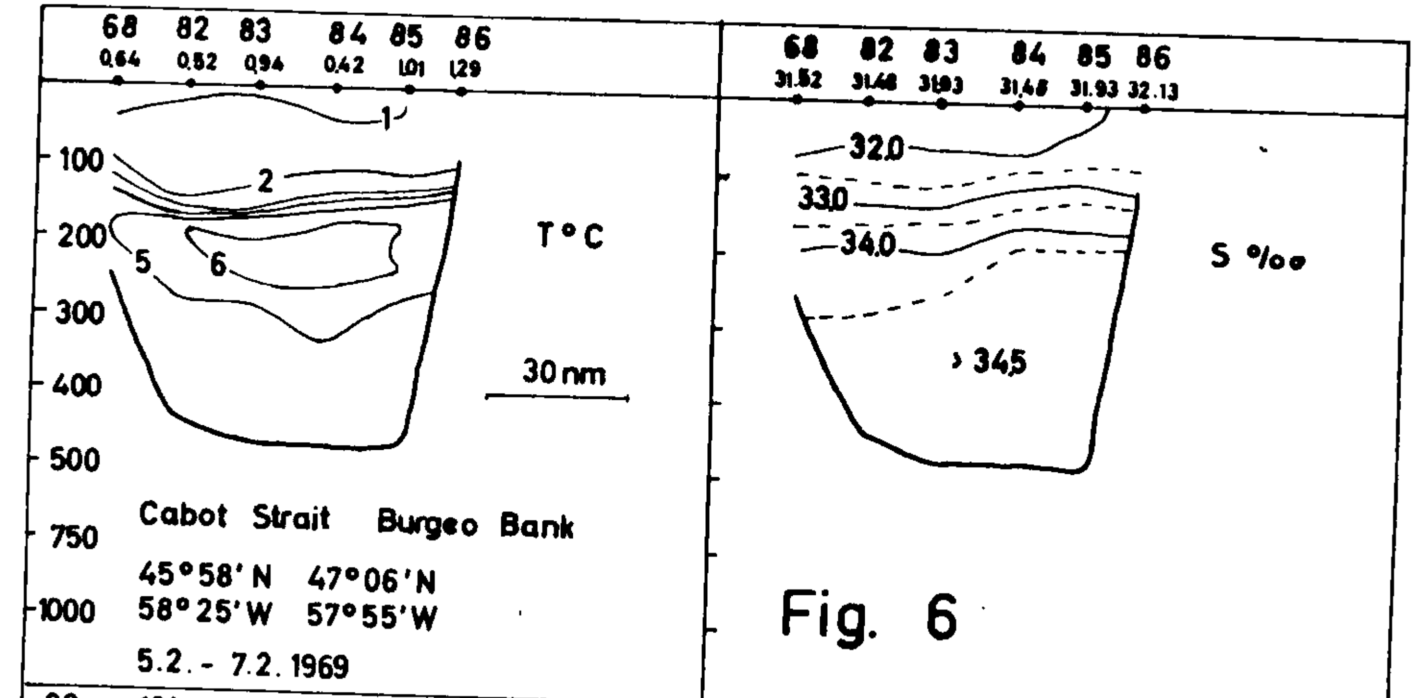
68 82 83 84 85 86
0.64 0.52 0.94 0.42 1.01 1.29
1
2
5
6
100
200
300
400
500
750
1000
T °C
30 nm
Cabot Strait Burgeo Bank
45°58' N 47°06' N
58°25' W 57°55' W
5.2. - 7.2. 1969
68 82 83 84 85 86
31.52 31.48 31.93 31.48 31.93 32.13
32.0
33.0
34.0
› 34.5
S ‰

Fig. 6

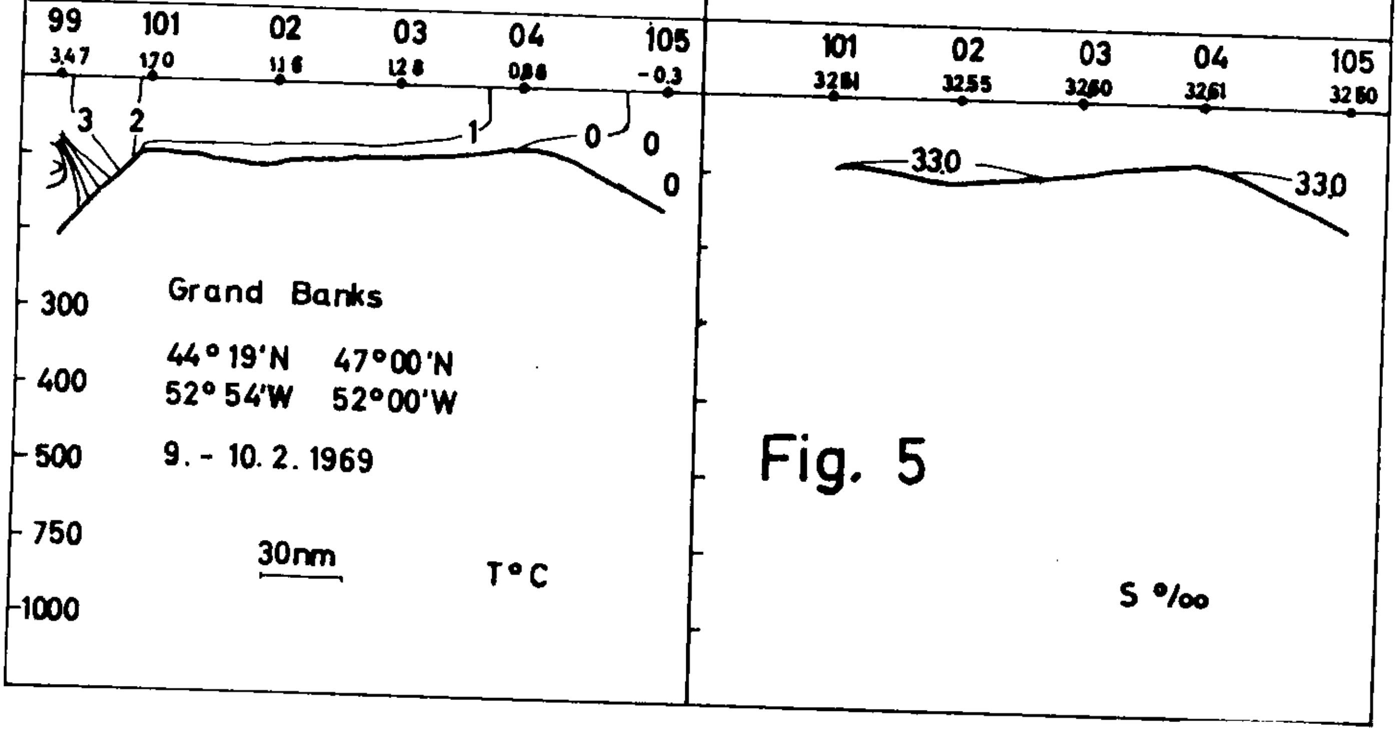
99 101 02 03 04 105
3.47 1.70 1.16 1.28 0.88 -0.3
3
2
1
0
0
0
300
400
500
750
1000
Grand Banks
44° 19'N 47°00'N
52° 54'W 52°00'W
9. - 10. 2. 1969
30nm
T °C
101 02 03 04 105
32.81 32.55 32.60 32.61 32.80
33.0
33.0
S ‰

Fig. 5

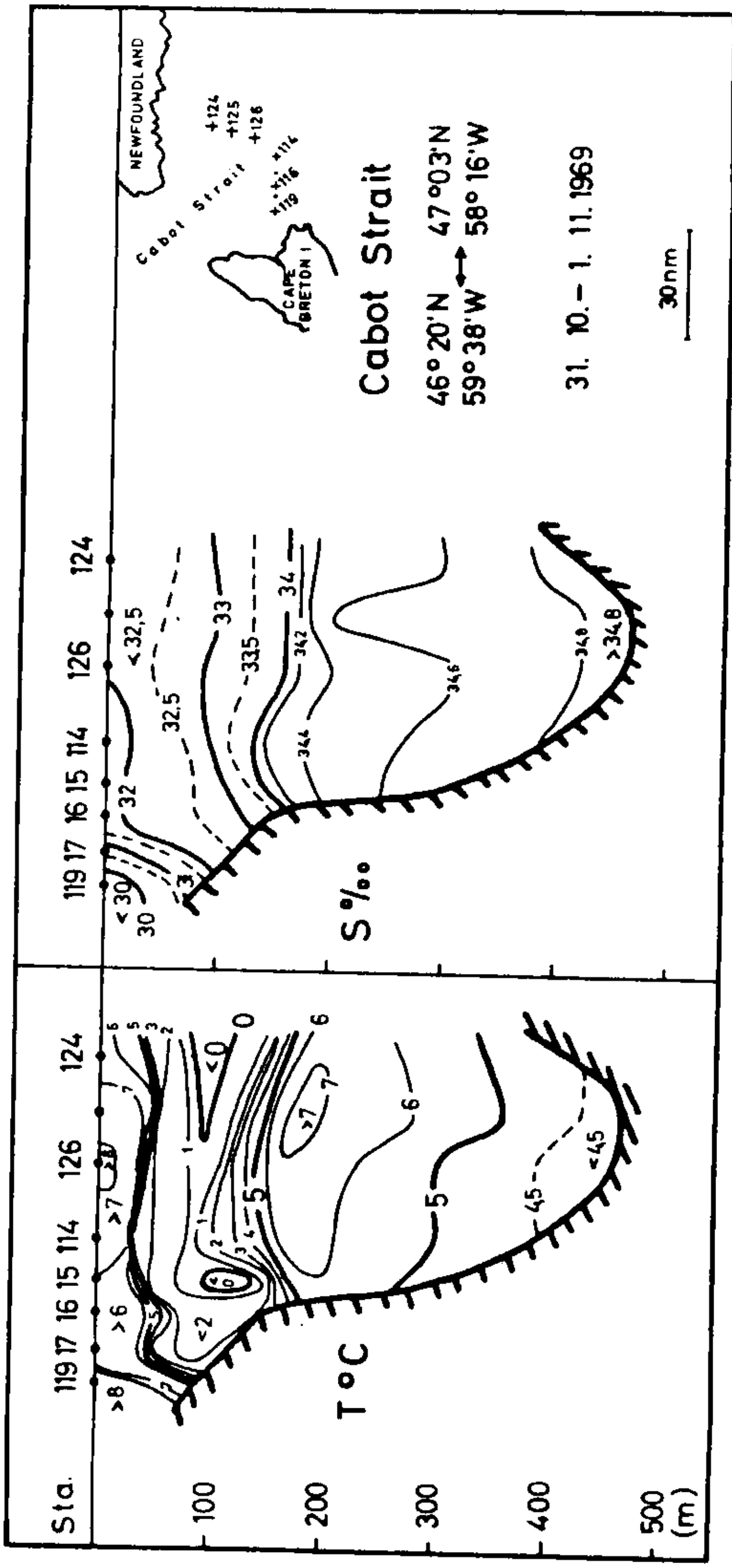
Sta.
119 17 16 15 114 126 124
100
200
300
400
500 (m)
T °C
S ‰
NEWFOUNDLAND
Cabot Strait
CAPE BRETON I.
Cabot Strait
46°20'N 59°38'W
47°03'N 58°16'W
31. 10.– 1. 11. 1969
30nm

Fig. 7

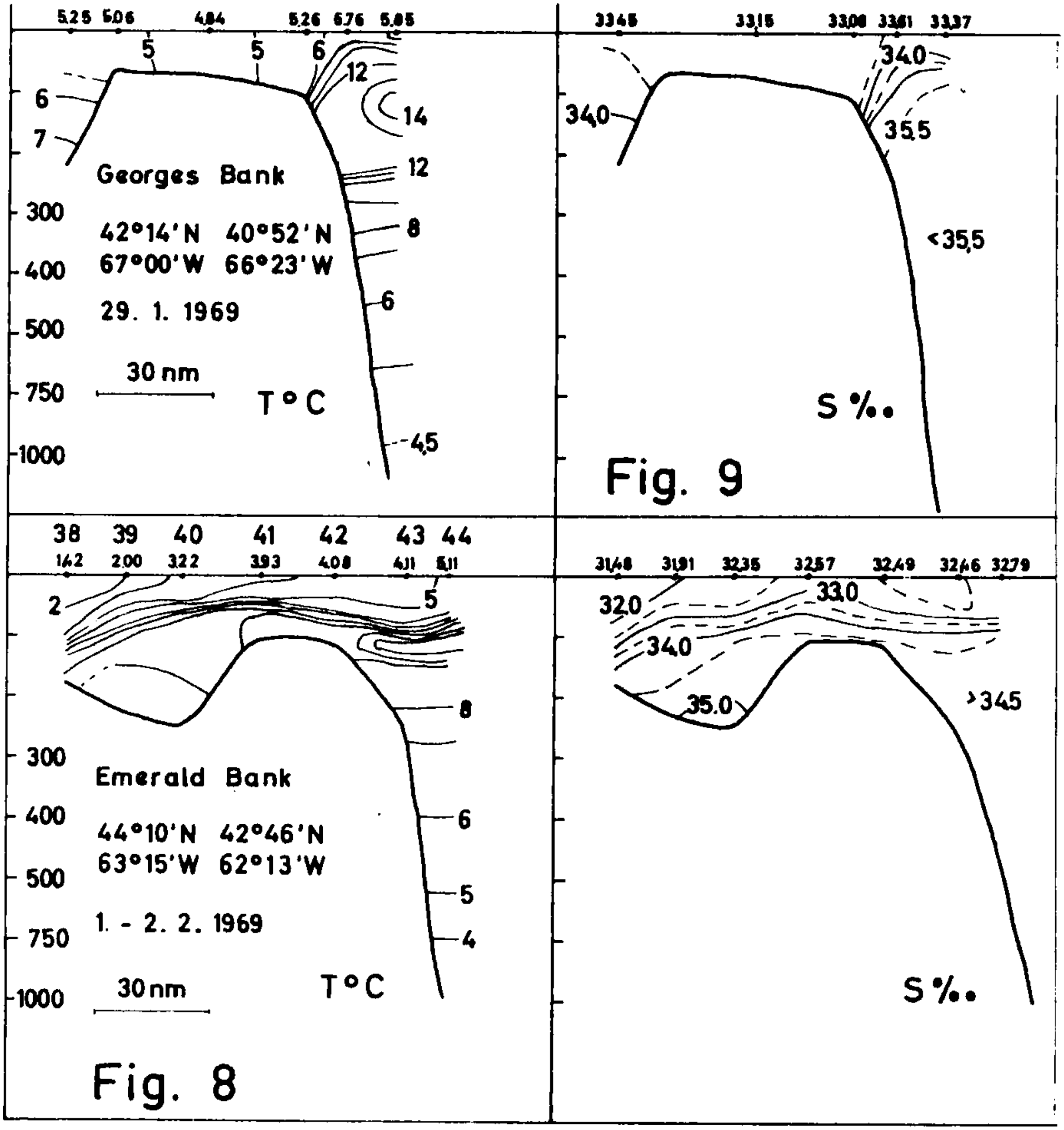
5,25 5,06 4,84 5,26 6,76 5,85
5 5 6 12 14 12 8 6 4,5
6
7
300
400
500
750
1000
Georges Bank
42°14'N 40°52'N
67°00'W 66°23'W
29. 1. 1969
30 nm
T °C
33,45 33,15 33,08 33,61 33,37
34,0
35,5
<35,5
S ‰
38 39 40 41 42 43 44
1,42 2,00 3,22 3,93 4,08 4,11 5,11
2 5 8 6 5 4
Emerald Bank
44°10'N 42°46'N
63°15'W 62°13'W
1. - 2. 2. 1969
31,48 31,91 32,36 32,57 32,49 32,46 32,79
32,0
33,0
34,0
35,0
>34,5

Fig. 9

Fig. 8

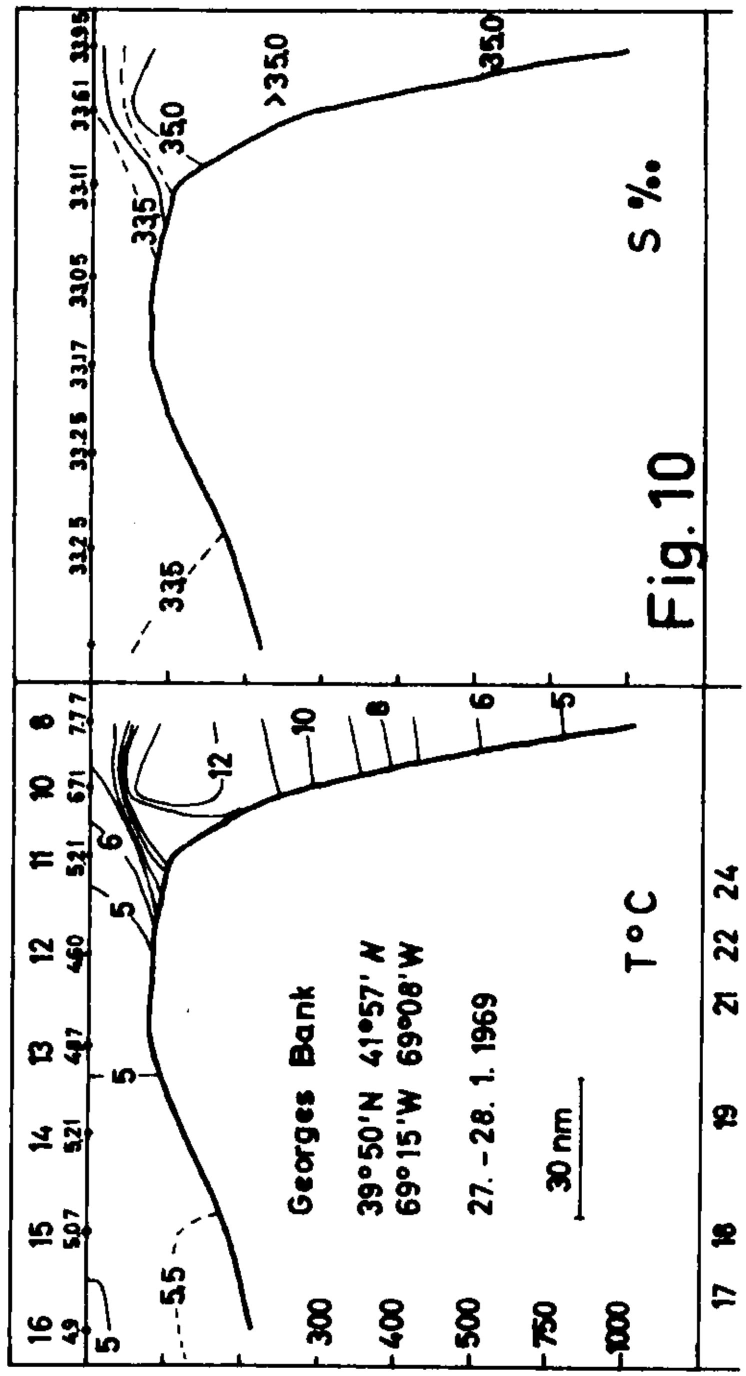

Fig. 10

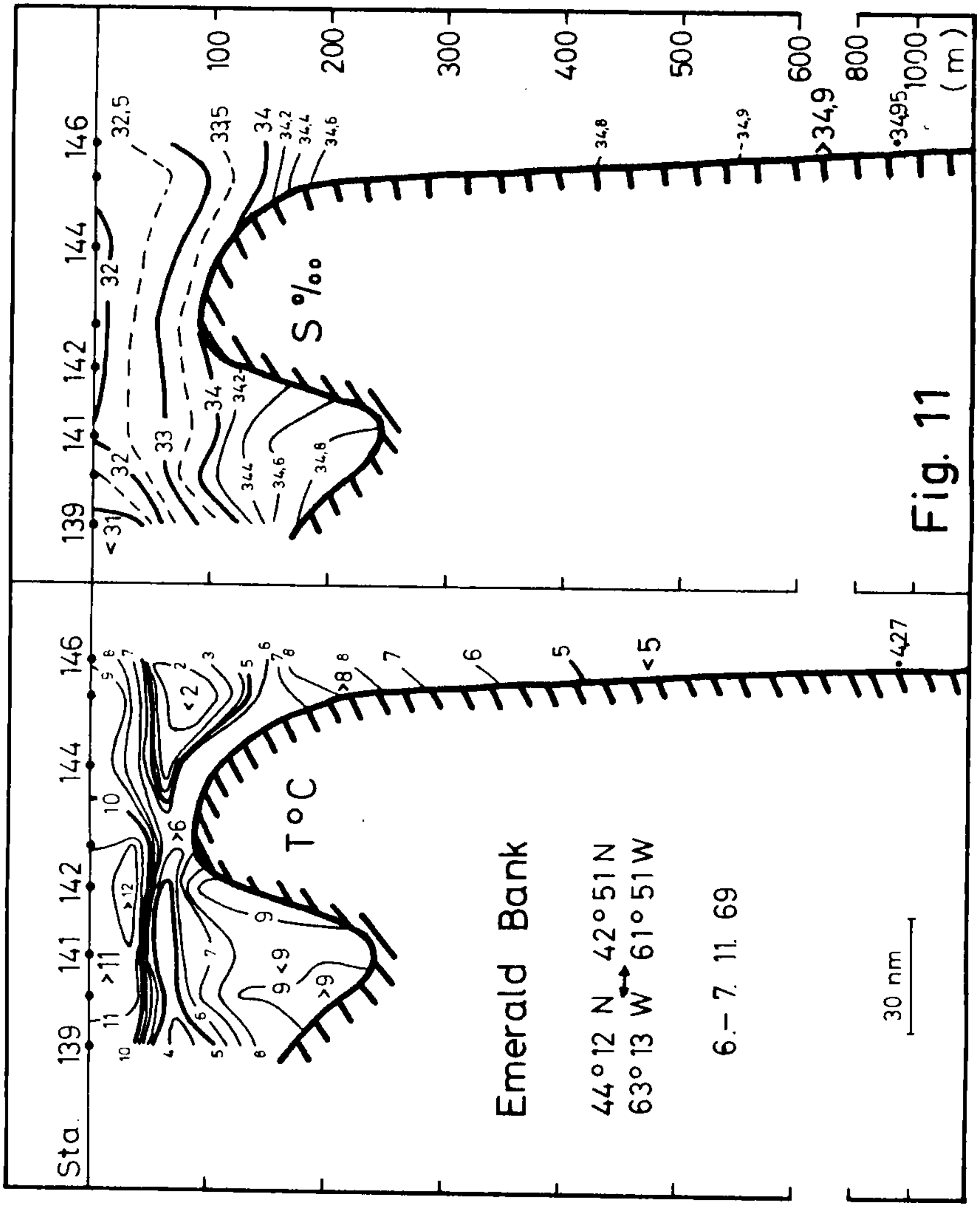
Sta.
139
141
142
144
146
100
200
300
400
500
600
800
1000
(m)
T°C
S ‰
Emerald Bank
44° 12 N 42° 51 N
63° 13 W 61° 51 W
6.– 7. 11. 69
30 nm

Fig. 11

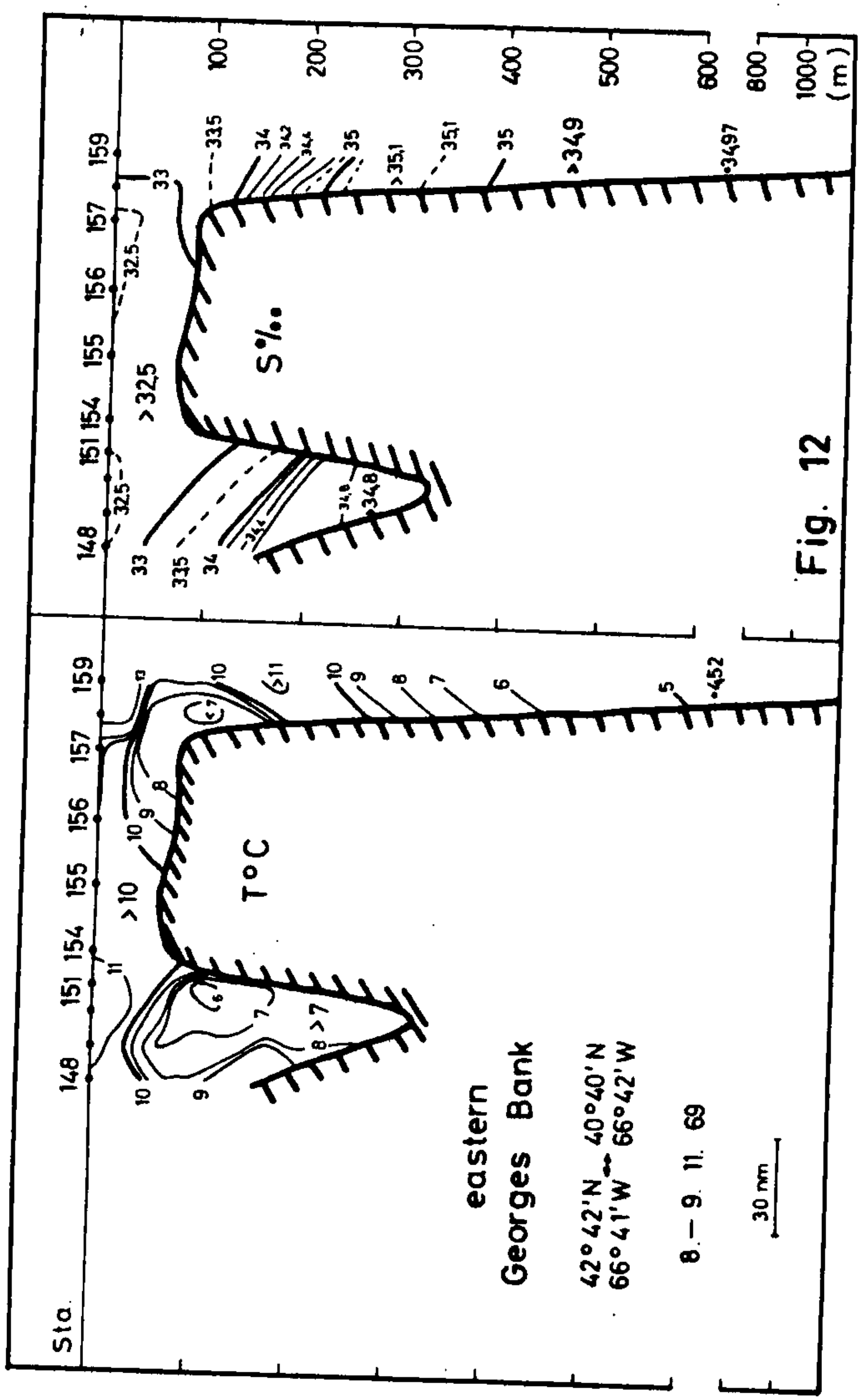
Sta.
148
151
154
155
156
157
159
T°C
S‰
eastern
Georges Bank
42°42'N → 40°40'N
66°41'W → 66°42'W
8.–9. 11. 69
30 nm
100
200
300
400
500
600
800
1000
(m)

Fig. 12

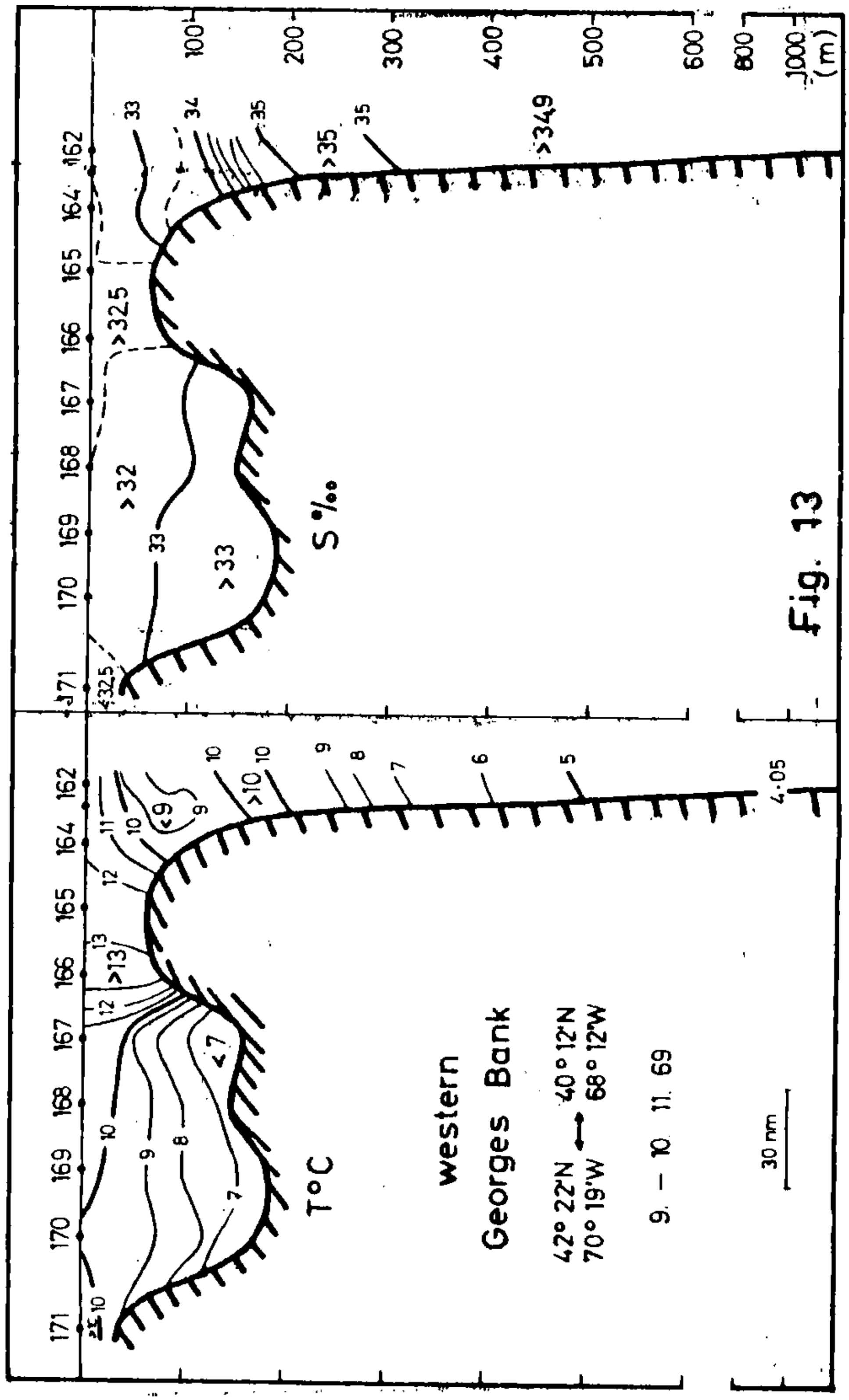
T°C
S ‰
western
Georges Bank
42° 22'N ⟷ 40° 12'N
70° 19'W ⟷ 68° 12'W
9. – 10. 11. 69
30 nm
171 170 169 168 167 166 165 164 162
100 200 300 400 500 600 800 1000 (m)
>13
<9
>10
<7
>32
>33
>32,5
>35
>34,9
4·05

Fig. 13

6. On the Appropriateness of the Flemish Cap Cod Stock[1] for Experimental Regulation of a Fishery

by K.G. Konstantinov
PINRO, Murmansk

Prior to 1957, fishing fleets operated on Flemish Cap irregularly and for a short period of time with vessels of all countries taking a total of about 1,300 metric tons of cod from 1953 to 1956 inclusive.

In the autumn of 1956, Soviet freezer trawlers (BMRT) started catching redfish on the southern and southwestern slopes of Flemish Cap. In the spring of 1957, cod were predominant in the catches. Since that time trawlers of some European countries have fished annually for cod on the southwestern part of the Bank at depths of 250-400 m in February-April. Main catch is mature cod in pre-spawning, spawning and post-spawning stages. Table 1 shows that the peak of the cod fishery on Flemish Cap is usually observed in March. Vessels take the largest catch per 1 hour trawling in February, March or April as well. For some years (e.g. 1956 and 1965) cod were also caught successfully in the autumn, mainly on the northeastern slope of the Bank. Seldom did the fishery peak during any month in summer or winter. Principle gear was otter trawl; longlines were seldom used. As mentioned above, in spring the fishing fleet catches mainly mature cod; during the other seasons immature cod make up a considerable part of the catches.

Table 1. Catches of cod in metric tons from Flemish Cap, 1957-1967

Year	Yield by all countries	Month of greatest catch	Country with greatest catch	Average catch per 1 hour trawling by Soviet BMRT in February-April
1957	17,799	March	USSR	3.22
1958	4,615	July	USSR	2.45
1959	6,949	October	USSR	2.34
1960	758	July	USSR	2.00
1961	10,341	March	USSR	-
1962	15,907	January	USSR	1.70
1963	33,413	March	France	4.09
1964	38,797	March	USSR	2.99
1965	53,850	November	USSR	-
1966	28,956	August	Portugal	-
1967	37,069	March	Portugal	1.66

Flemish Cap has a single isolated cod population that never mixes with cod of the Great Newfoundland Bank. Isolation of the Flemish Cap population has been demonstrated from the results of tagging. Table 2 includes data on cod tagged from Soviet research vessels on Flemish Cap and recaptured by Soviet fishing vessels and those of the other countries. Only

[1] submitted to the 1970 Annual Meeting of ICNAF as ICNAF Res.Doc. 70/46.

data from those tagged specimens for which the location of their recapture was known to be reliable were used.

Table 2 shows that the cod tagged on Flemish Cap do not leave the Bank. There are no records of tagged cod having migrated onto Flemish Cap from other areas, even though Soviet ichthyologists had tagged over 35,000 cod in Subareas 2 and 3 from 1960 to 1966 (Konstantinov, 1967a).

Isolation of the Flemish Cap cod population makes it possible to find out what influence the fishery can have on the stock of fish. It should also be noted that the size of the cod stock on Flemish Cap could not be very great because of the small area.

Further, it may be assumed that natural fluctuations of the abundance of year-classes of cod on Flemish Cap are insignificant. The area has extremely stable oceanological conditions. Throughout the year water temperatures at all depths deviate from 3.5°C by only some tenths of a degree. Year to year fluctuations of water temperature are also particularly insignificant. Many investigators (Izhevsky, 1961; Antonov, 1964; Kislyakov, 1964; Templeman, 1965) have proved conclusively that there is a close relationship between oceanological conditions and abundance of fish year-classes. Thus, one can expect a relatively constant annual recruitment to the fishable stock of cod. This is suggested by data collected regularly by the Soviet ichthyologists to determine the abundance of the young in Subareas 2 and 3 (Bulatova, 1968).

Thus, good grounds exist for an assumption that one may estimate the influence of the fishery on the cod stock on Flemish Cap. In the first place, no notable fishery took place on Flemish Cap before 1957. However, from 1957 to 1967 reliable statistical data on catches and size-age composition of fish are available. In the second place, each spring, the trawlers exploit a definite part of the population - mature cod. But an intensive fishery may markedly affect the abundance and size-age composition of mature cod, e.g. the Arcto-Norwegian stock of cod as shown by Saetersdal and Hylen, 1964. Third, the cod population on Flemish Cap is separate and not large. In the fourth place, annual recruitment to the stock is evidently constant, thus making the effects of depletion of the stock by the fisheries more pronounced. Sharp fluctuations in the strength of year-classes can completely overbalance the influence of a fishery on stocks of gadoid fish. Striking examples are cod and haddock of the North Sea (Report of the Working Group on Assessment of Demersal Species in the North Sea, 1969), cod in the Barents Sea (Konstantinov, 1967b, 1969), haddock of the Barents Sea (Sonina, 1969) and cod of the Baltic Sea (Antonov, 1964).

Templeman and Gulland (1965) note that "In most fisheries, therefore, where there are fluctuations in recruitment or other factors, independent of the amount of fishing, it is difficult to predict what the absolute magnitude of the catch would be with any pattern of fishing, or to say that the catch in any particular year following some regulation (e.g. an increase of mesh size) will necessarily be greater than before the regulation. What is possible is to determine that catches following some regulation will be greater than they would have been if the regulation had not been introduced."

In other words, in most oceanic fisheries it is difficult to trace the influence of fisheries on stocks as this is overbalanced by the action of other more important factors. However, the features common to Flemish Cap mentioned above offer particularly favourable conditions to determine the influence of fisheries on cod stocks.

Figure 1 shows that the age composition of spawning cod changed from 1957 to 1963 with the peak of the age frequency displacing to the left. It is safe to attribute these changes to an increasing yield of cod. Figure 2 shows the relationship between the total yield of cod and the subsequent catch-per-unit effort. In the figure, the dotted line indicates an average catch per 1 hour trawling by the Soviet BMRT in February-April on the south-western slope of the Flemish Cap; the solid line, the total yield of cod taken by all countries over the whole of Flemish Cap during the previous four years. The curves show that with increasing total yield of cod there was decreasing productivity of the trawl fishery on the spawning ground. Such a mirror relationship is observed on comparing the data for 1964 and 1967. However, 1963 does not follow the general relationship due to a sharp increase in fishing efficiency. It is difficult to explain this exception. It is possible that environmental conditions (e.g. anomalies of water temperature), may have increased the density and stability of the spawning concentrations. The influence of environmental conditions on the productivity of trawl fisheries is well established for the Barents Sea cod (Konstantinov and Mukhin, 1965; Konstantinov, 1967b, 1969; Mukhin, 1967) and to a limited extent for cod in the Labrador area (Konstantinov, 1968). As for cod on Flemish Cap after 1963 a further increase in yield was accompanied by a steady decrease in average catch per 1 hour trawling.

The data suggest that at present, the cod yield from Flemish Cap exceeds the optimum level and that a decrease in annual yield would probably help to restore fishery productivity and the length composition of fish in the catches.

Figure 2 shows that as long as the total yield of cod on Flemish Cap did not exceed 10,000-12,000 tons annually (or 40,000-50,000 tons for four years), it was possible that an incidental increase in the average catch per 1 hour trawling could take place in spite of the evident decreasing trend. To increase this catch per 1 hour trawling again, it is probably necessary to set the total annual yield of cod on Flemish Cap at 10,000 tons.

Decrease in yield will not be a great privation for any country. Thus, the Flemish Cap is an extremely appropriate area for the experimental regulation of fisheries.

Table 2. Recoveries of cod tagged and released on Flemish Cap by Soviet research vessels, 1961-1966.

Released						Recaptured			
Date	Position N	Position W	Length of cod (cm)	No. of tag	Country	Date	Position N	Position W	
23 Mar. 1961	46°39'	45°52'	58	7927	USSR	28 Jun. 1961	46°50'	46°05'	-
23 Mar. 1961	46°39'	45°52'	58	7931	France	14 May 1964	46°30'	46°30'	-
12 Mar. 1963	45°26'	45°30'	52	7733	Spain	22 Aug. 1963	45°26'	45°30'	54
14 Mar. 1963	46°30'	45°33'	59	20053	France	9 Aug. 1963	46°30'	46°00'	60
14 Mar. 1963	46°28'	45°53'	52	21769	Spain	20 Aug. 1963	46°26'	45°30'	54
27 Feb. 1965	46°38'	46°06'	53	26925	USSR	5 May 1965	46°50'	45°45'	53
28 Feb. 1965	46°34'	45°47'	72	35081	USSR	10 Jun. 1965	46°41'	45°33'	73
28 Feb. 1965	46°34'	45°47'	75	35087	USSR	5 Aug. 1965	46°30'	45°15'	76
28 Feb. 1965	46°34'	45°47'	56	35099	USSR	2 Jun. 1965	46°50'	45°45'	57.5
27 Feb. 1965	46°39'8	46°13'9	60	35097	USSR	30 May 1965	47°58'	45°03'	-
28 Feb. 1965	46°34'3	45°47'4	63	35048	Poland	21 Nov. 1965	47°43'	44°43'	66
11 Dec. 1966	46°59'	45°35'	58	106282	Norway	2 Jun. 1968	47°00'	45°00'	-
11 Dec. 1966	46°59'	45°35'	59	106219	Portugal	15 Mar. 1967	46°28'	45°23'	-
12 Dec. 1966	46°53'	45°29'	64	106345	England	22 Aug. 1967	46°30'	45°40'	-
12 Dec. 1966	46°55'	45°31'	65	106389	Norway	8 Oct. 1968	47°00'	45°00'	71

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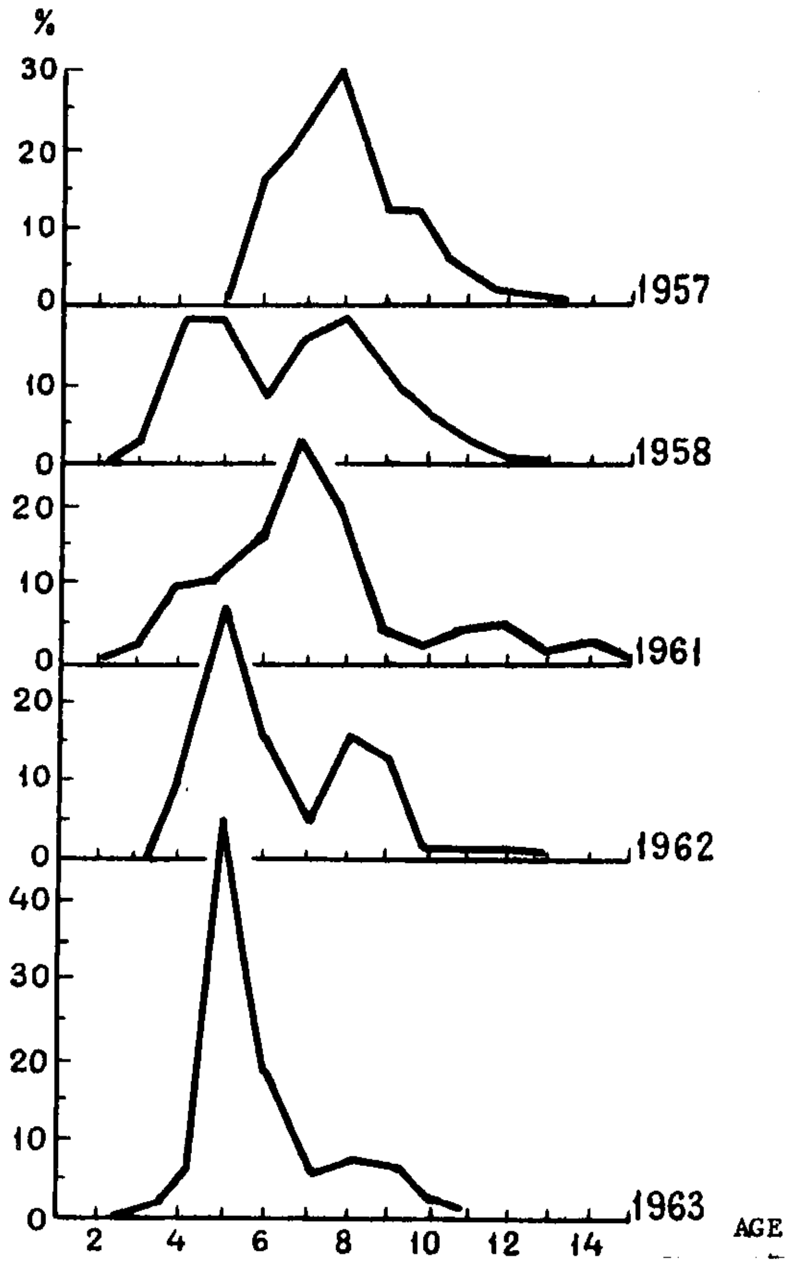

Fig. 1. Age composition of cod on the southwestern slope of Flemish Cap in 1957, 1958, 1961, 1962 and 1963.

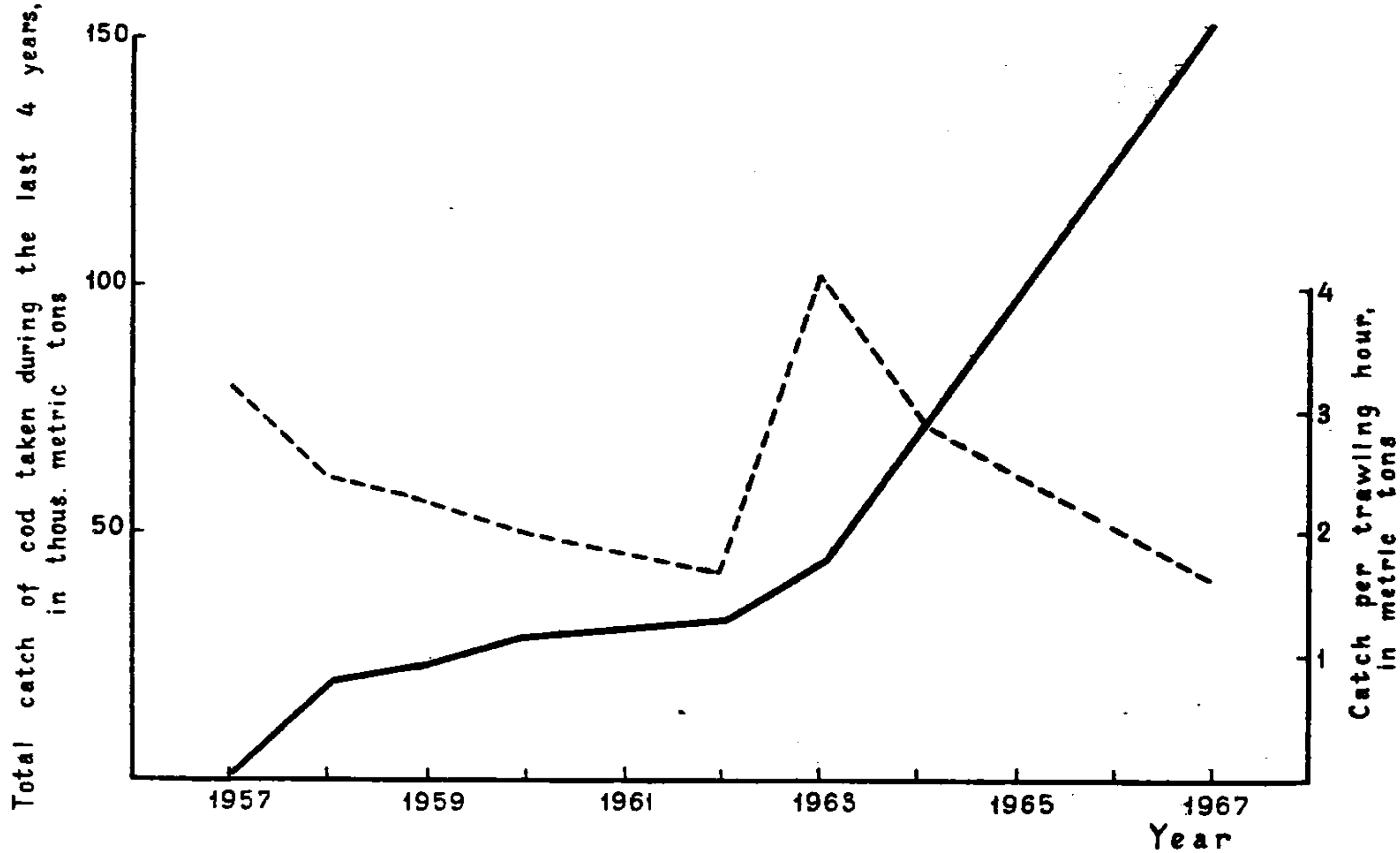

Fig. 2. Total yield of cod by all countries from Flemish Cap during the four years previous to 1957-67 (solid line) and the catch per 1 hour trawling by Soviet BMRT in the southwestern part of Flemish Cap Bank in February-April of 1957-67 (dotted line).

7. Abundance of Young Cod in the waters off Newfoundland[1]

by A. Yu. Bulatova
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Introduction

To investigate changes in the state of the stocks of commercial fishes ichthyologists use, along with other methods, the numbers of young fish. Data on relative abundance of young cod during their first three years of life can serve as a basis for forecasting future catches.

Materials and methods

For 9 years since December 1961 Soviet ichthyologists have determined the abundance of young cod in ICNAF Subarea 3. Data were collected by the big side trawlers of 2,800 tons displacement. A bottom trawl with a 31.4 m headline was used. An 8-mm mesh (knot-to-knot) capron net of 8 m in length was inserted into the codend.

A series of trawl hauls was made at stations located regularly at different depths throughout Subarea 3. All the trawl-caught young up to 35 cm in length were counted but since 1968, when observations were made late in the season, young up to 40 cm in length were counted. The average catch of specimens per 1 hour trawling was taken as an index of year-class abundance.

Results of investigations carried out in April-July 1969 are presented in this paper.

Distribution of young cod, April-July 1969 (Fig. 1 and 2, Table 1)

The North Newfoundland Bank (Div.3K)

In June-July 1969 the young were distributed in loose concentrations. As in previous years they occupied depths of 150-350 m, and occurred mainly in near-bottom waters at temperatures from 1 to 3°C. Catches taken off the coast were somewhat greater compared to those taken in the offshore part of the Bank. Maximum number of specimens taken per hour was not higher than 200; the average catch was 58 specimens.

The Great Newfoundland Bank (Div.3L, 3N, 3O)

Evidently in April the young start migrating from the slopes to the shallows of the Great Newfoundland Bank and their distribution corresponds to the spreading of the near-bottom waters with different temperature gradients.

In the northeastern part of the Great Newfoundland Bank, small cod up to 40 cm in length were distributed over a large area at depths from 100 to 250 m with the temperatures from 0 to 1.5°C.

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The waters of the Great Newfoundland Bank less than 100 m deep and north of 45°00'N had near-bottom temperatures from 0.2-0.4°C. Here,catches of young were not more than 25 specimens per haul.

To the south the number of young in the catches increased gradually reaching a maximum in the western part of the southwest slope, where at a water temperature of 2°C at 85 m in depth, 650 specimens were caught per hour. This concentration was found in waters with high temperature gradients. Perhaps, the influx of warm water favoured the displacement of young from the southwest slope into the shallows; the number of specimens remaining on the continental slope was insignificant.

Also in May, young from the southeastern part of the Bank remained on the slope in a stream of cold water at a depth of 100-200 m and a temperature of 0.2 to 0.8°C. This stream was observed along the slope up to "tail" of the Great Newfoundland Bank and was bounded on both sides by warm waters with temperatures up to 3°C. Maximum catches in the frontal zones reached 500 specimens per hour.

Table 1. Distribution of young by depths in different ICNAF divisions.

Depth (m)	3M		3K		3L		3N		3O		3P	
	q	n	q	n	q	n	q	n	q	n	q	n
1-50							1	0	-	-	2	15
51-100	-	-	-	-	11	55	21	23	26	96	15	49
101-150	1	58	-	-	12	140	8	222	7	20	12	219
151-200	2	34	5	57	21	105	7	231	7	11	13	130
201-250	7	65	14	96	19	102	5	83	1	0	5	15
251-300	4	15	13	50	7	48	4	172	1	6	1	0
301-350	2	4	9	55	3	28	-	-	-	-	1	1
351-400	-	-	4	16	-	-	1	0	-	-	-	-
401-450	-	-	4	2	-	-	-	-	-	-	-	-

Note: q - number of trawlings;
n - average number of specimens per 1 hour trawling.

The Saint Pierre Bank (Div. 3P)

On St. Pierre Bank, young were caught in smallest numbers off the coast. Their number increased in catches towards the continental slope, where 723 specimens were taken at 100-150 m (at 5.7°C) and 809 specimens (at 0.5°C). the temperature of the near-bottom waters in this area fluctuated from -0.1°C to +5.8°C at a distance of 3 miles. Thus, the greatest concentrations of young and adult cod were observed in the frontal zones.

In spite of the fact that in spring and at the beginning of summer, the young migrate to the shallows, they probably do not migrate extensively to the coast and back, similar to adult cod, and during their first three years remain near the place where they began living on the bottom.

Assessment of abundance of year-classes of young cod (Table 2; Fig. 3 and 4)

The North Newfoundland Bank (Div. 3K)

Catches of young cod on the north Newfoundland Bank can be considered an indicator of the abundance of the Labrador cod stock. This is based on studies of the ecology of the Labrador cod stock by Fleming (1958), Templeman, (1962), Serebryakov (1967), Postolaky (1963, 1968), Konstantinov and Noskov, (1967) and Elizarov (1963).

Generally fish 3 to 4 years of age were prevalent in catches which were taken on the bank area (Bulatova, 1968). The number of young (1 to 2 years of age) is small, being somewhat greater in coastal areas compared to offshore bank areas. On this basis it could be that the main mass of cod larvae from the Labrador spawning grounds is carried downstream to the coast of the South Labrador and Newfoundland where they go to bottom. Young adults 2 to 3 years of age move offshore and migrate northward. Canadian researchers from the Fisheries Research Board of Canada, Biological Station, St. John's, Newfoundland, have the same views on this subject.

In the summer of 1969 on the north Newfoundland Bank, 3- and 4-year olds of the 1966 and 1965 year-classes were prevalent in catches of young cod. Average catch of 3-year olds of the 1966 year-class was greater than the catches of 3-year olds of the two previous year-classes and apparently, the strength of the 1966 year-class will be greater than average. The same may be said about the 1967 year-class which as 2-year olds were more numerous in catches than the 2-year olds of the previous year-classes.

Comparison of the strengths of the 1960 to 1966 year-classes of cod on the north Newfoundland Bank and in the Barents Sea (Baranenkova, 1968; Nizovtsev and Trambachev, 1969), then shows that they fluctuate in an opposite direction. Unfortunately, one set of observations is insufficient to provide proof of this relationship.

The Great Newfoundland Bank (Div. 3L, 3N, 3O)

The northeast slope of the Great Newfoundland Bank may serve as a mixing place for the Labrador and south Newfoundland cod stocks. Evidently, in April 1969 a number of 4-year olds of the 1965 year-class (Fig. 2) which were prevalent in the young catches on the southeast slope (Table 2) had penetrated onto the northeast slope.

The same mixing apparently takes place on the southwest slope of the Great Newfoundland Bank between the south Newfoundland cod and the Saint Pierre cod. Trawlings on the boundary between the southwest (Div.3O) and southeast slope (Div.3N) took a greater quantity of larger young of the 1965 and 1966 year-classes; nearer St. Pierre, mainly young of the 1968 year-class, 10-16 cm in length, were caught.

Abundance of the 1966 year-class of cod on the Great Newfoundland Bank was a little higher than that of previous year-classes except the 1964 year-class. The 1967 year-class was poor both in the first and second year of life. The 1968 year-class will probably be of great importance to the fishery.

The St. Pierre Bank (Div. 3P)

The 1968 year-class was especially numerous on St. Pierre Bank. Evidently, favourable conditions observed in 1968 made for a rich year-class on St. Pierre Bank and the southwest slope of the Great Newfoundland Bank. Average catch of young cod of the 1967 year-class at the second year of life increased to 20 specimens, but it is hardly probable that this year-class will be better than average. As on the Great Newfoundland Bank the 1966 year-class was a little better than the long-term mean level.

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Table 2. Average catches (number of specimens) of young cod per 1 hour-trawling of different year-classes on the Newfoundland Banks.

Year classes	1 year					2 years					3 years					4 years				
	3K	3L	3N	30	3P	3K	3L	3N	30	3P	3K	3L	3N	30	3P	3K	3L	3N	30	3P
1958	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	10	1	0	2
1959	-	-	-	-	-	-	-	-	-	-	21	21	8	1	4	15	10	1	1	1
1960	-	-	-	-	-	5	2	3	0	3	11	8	1	2	5	11	8	1	0	1
1961	1	1	1	1	6	3	4	4	3	6	20	28	5	1	6	24	11	4	1	1
1962	1	1	1	7	42	2	5	8	2	7	15	40	18	2	12	24	13	6	1	2
1963	1	2	1	1	3	1	8	5	1	13	36	31	30	1	17	17	33	7	3	4
1964	1	1	41	24	31	3	15	137	13	22	8	48	73	42	58	28	28	16	7	10
1965	1	1	1	1	5	1	1	14	12	21	15	12	23	20	25	22	37	60	9	9
1966	0	0.1	2	15	7	3	8	27	17	32	27	43	37	34	28	-	-	-	-	-
1967	0.2	0.5	0.2	2	0.3	8	11	3	4	20	-	-	-	-	-	-	-	-	-	-
1968	0.5	1	6	18	40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

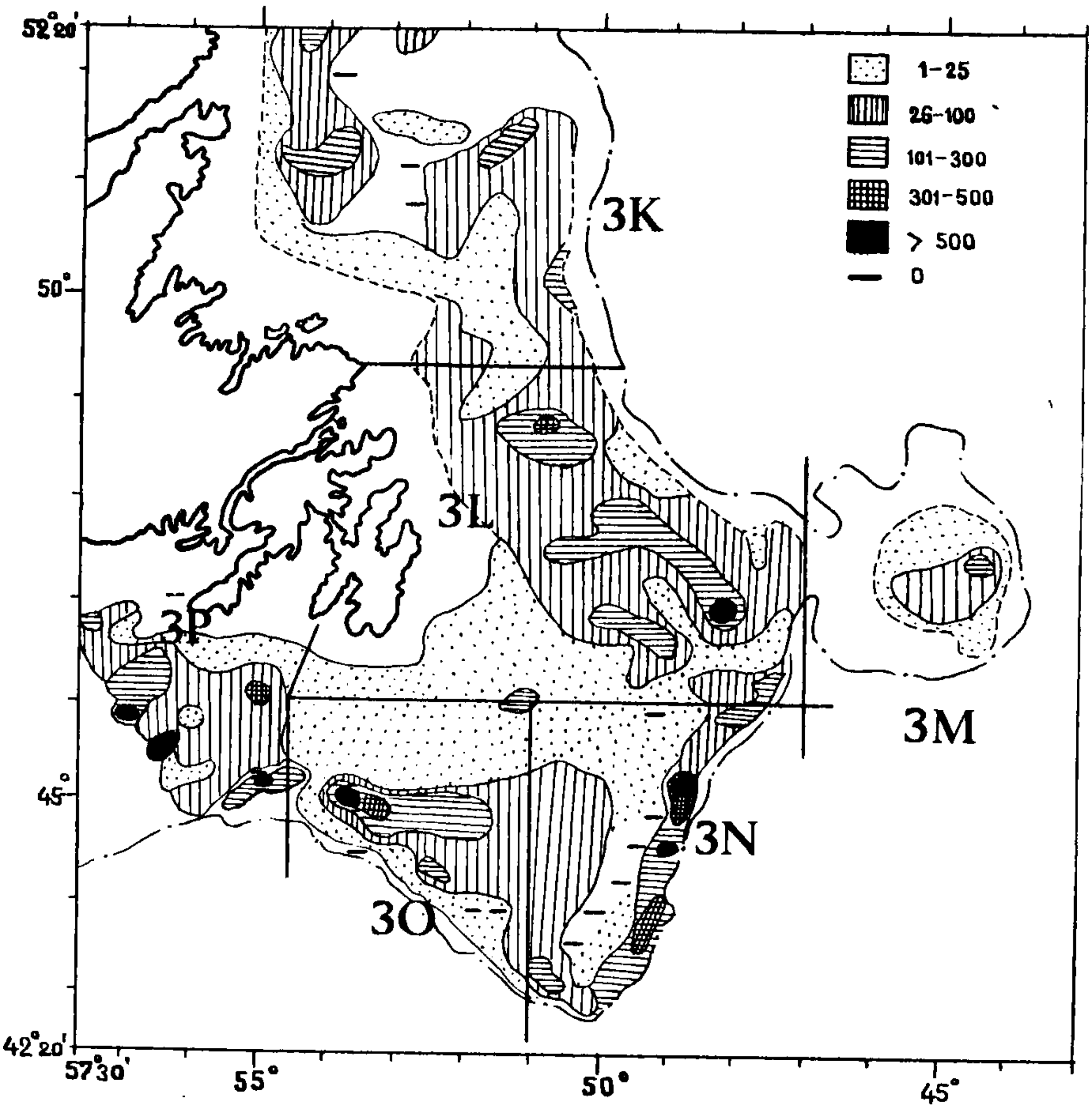

Fig. 1. Young cod distribution (catches in numbers of specimens) in ICNAF Subarea 3.

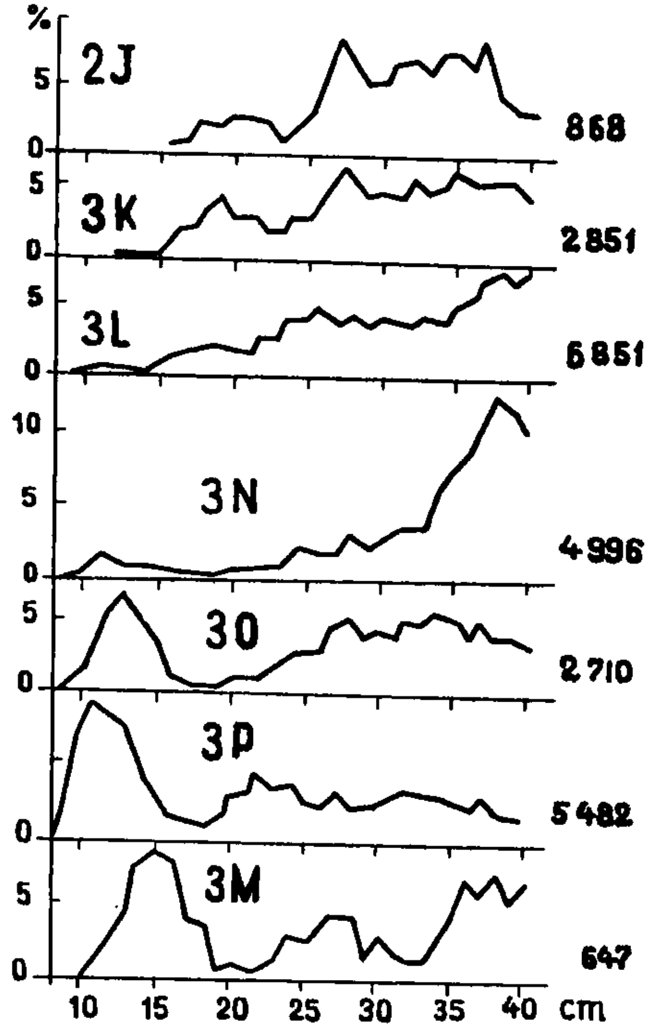

Fig. 2. Length composition of young cod in different ICNAF divisions.

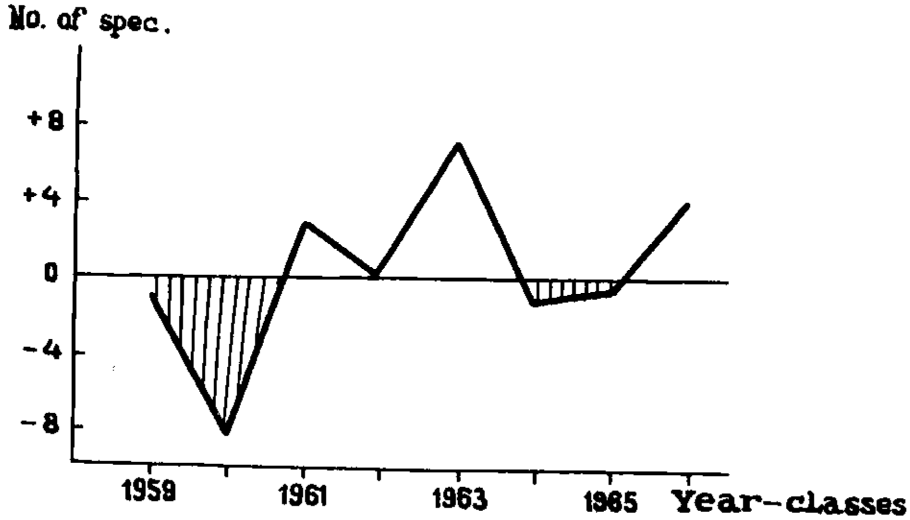

Fig. 3. Total abundance of young cod aged 3 and 4 on the north Newfoundland Bank as deviations from the long-term level.

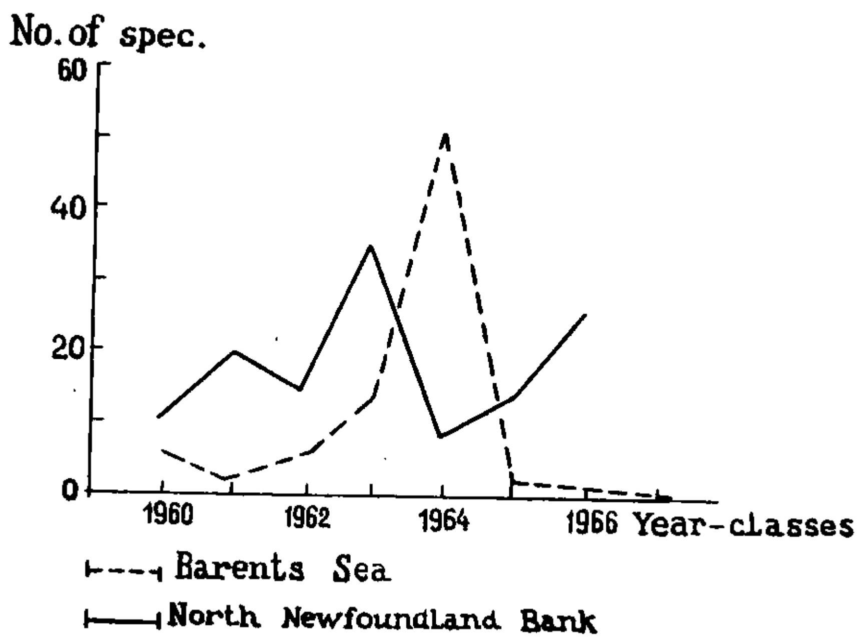

Fig. 4. Fluctuations in abundance of 3-year-old cod of different year-classes on the north Newfoundland Bank and of 2- and 3-year-olds in the Barents Sea (Area 1).

8. Catch/Effort Assessments for the Major Cod Stocks in ICNAF Subareas 2 and 3[1]

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Abstract

Estimates of parameters derived during current mesh assessment studies are used in catch/effort assessments of the major cod stocks in ICNAF Subareas 2 and 3. It is concluded that for the stocks in ICNAF Div. 2J, 3KL, 3NO, and 3Ps the level of exploitation is at least close to that generating the maximum sustained yield and may in some cases, notably 3KL and 3Ps, be well beyond this level. Estimates of the actual maximum sustained yields in metric tons are also presented as well as the possible effort changes from the present level of fishing necessary to achieve these maximum yields.

Introduction

Previous catch/effort assessments for Subareas 2 and 3 cod have been reported by Beverton (1965) using 1956-58 data (except for L_∞ and K estimates and hence M/K where 1960-62 data were used) and by May (1967) using 1963-64 data. In both these cases the assessment was based on the constant parameter yield per recruit model as developed by Beverton and Holt (1957) using the FAO yield tables (Beverton and Holt, 1964). In addition, Garrod (1969) assessed the state of the fisheries using a "Schaefer type" model on the catch/effort relationship. His data extended to 1966. In the present study assessments are reported on Subareas 2 and 3 cod using the constant parameter model with the data being taken from the 1964-68 period. Gross estimates of trends in effort and catch per unit of effort are also included.

Materials and methods

Figures used in the calculation of trends in catch and effort were taken from ICNAF Statistical Bulletins for the years 1959-68 and were treated in the following manner: Landings and hours fished for each year were first tabulated by country for those countries reporting hours. Portugal and Spain were found to have the most consistent record of catches in relation to effort over the period and from area to area and were therefore selected as the standard for estimation of total effective effort. Since it has been found by several authors (Hodder, 1965; Wiles, 1967; Pinhorn, 1969a,b) that the ratio of Spanish to Portuguese landing per hour is between 0.8 and 0.9, the hours fished by Spanish otter trawlers and pair trawlers were combined and

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[1] submitted to the 1970 Annual Meeting of ICNAF as ICNAF Res.Doc.70/67

reduced to 0.8 before being added to Portuguese otter trawl hours. From this effort and the combined landings of the two countries corresponding to it, the landing per standard Portuguese otter trawler hour was calculated for each year. These values were then divided into the total landings of all countries and gears to arrive at an estimate of total effective effort for each year.

Parameters used in constructing yield per recruit curves from FAO Tables are shown in Table 1. Values of L_c shown are averages for the entire fishery in a particular division derived by weighting the L_c's of the various gears in each division by the catch of each gear. Values of L_∞, K and Z are taken from Pinhorn (1969a) and Pinhorn and Wells (1970) and are values used in mesh assessment studies for these same areas. Methods of deriving these estimates are outlined in these papers. Values of M chosen are those believed to cover the range of M likely to occur in these areas, since reliable estimates of this parameter are still not available.

Results

Trends in landings and effort

Total landings from Subarea 2 have shown a marked increase in the 1959-68 period from about 60,000 metric tons in 1959 to 400,000 metric tons in 1968 (Fig. 1). Associated with this has been a corresponding increase in total effort from 50,000 standard Portuguese otter trawler hours in 1959 to 170,000 hours in 1968. Catch-per-unit-effort also increased from 1.3 to 2.4 tons per hour during the same period.

In Div. 3KL, although total landings have fluctuated somewhat, there has been a general increase from about 270,000 tons in 1959-60 to 420,000 tons in 1968. Total effort fluctuated only slightly around 180,000 hours during 1959-66 but then increased to 240,000 hours in 1968. Landings per hour changed very little over the period although there has been a net increase from about 1.4-1.5 tons in 1959-60 to 1.7-1.8 tons in 1967-68.

Total landings from Div. 3M increased from about 7,000 tons in 1959 to 54,000 tons in 1965 but decreased to 30-36,000 tons thereafter. Total effort increased from about 5,000 hours in 1959-60 to 40,000 hours in 1965 and decreased to 20,000 hours thereafter. Landings per hour have fluctuated widely around 2 tons per hour.

In Div. 3NO total landings remained at about 60,000 tons during 1959-64 but then increased to 220,000 tons in 1967. Landings decreased again to 160,000 tons in 1968. Total effort decreased from about 60,000 hours during 1959-61 to 30,000 hours during 1962-63 and then increased steadily to 100,000 hours in 1967. This was followed by a decrease to 80,000 hours in 1968. Landings per hour remained at 1.0-1.2 tons during 1959-62 but then increased to a level of 2 tons during 1963-68.

Having increased from 60,000 tons in 1959 to 80,000 tons in 1961, total landings from 3Ps decreased to a level of 50,000 tons in 1962-65 and then increased to 75,000 tons in 1968. Total effort decreased from 65,000 hours in 1959 to 27,000 hours in 1965 and then increased to 35,000 hours in 1967-68. Landings per hour increased from 1 ton in 1959 to 2 tons in 1968.

Total landings from Div. 3PN-4R increased from 50,000 tons in 1959 to 85,000 tons in 1961 and then decreased to 60,000 tons in 1966. This was followed by an increase to 80,000 tons in 1968. Total effort decreased from about 30,000 hours in 1959-62 to 20,000 hours during 1963-66 and then increased to 40,000 hours during 1967-68. Landings per hour rose from 2 tons in 1959-60 to a peak of 3.3 tons in 1964 and then dropped to 1.8 tons in 1967. There was a slight increase to 2.3 tons in 1968.

Catch/effort assessments

Although the lack of reliable estimates of some of the parameters, notably M, precludes a detailed assessment of the stocks of cod in Subareas 2 and 3, some general conclusions about the state of the fisheries can nevertheless be drawn.

For all the major stocks of cod in Subareas 2 and 3, yield per recruit assessments indicate that the level of fishing prevailing during 1964-68 for Div. 2J, 3KL and 3Ps and 1963-66 for Div. 3NO was at least near the point of maximum sustained yield-per-recruit and may in some cases have been beyond it (Fig. 2 and Table 2). This is certainly true of Div. 3KL where the level of effort was at the point of maximum yield-per-recruit even at the highest value of M assumed. For all other divisions the most conservative estimate (highest value of M) suggests that the present yield is at least within 90% of the maximum yield per recruit (Table 2). Therefore, assuming constant recruitment at the level prevailing in the period under consideration, an increase in effort is not likely to result in any sustained increase in yield from these fisheries and could result in a decrease on a long-term basis. Also, increased effort will most likely result in a long-term decrease in catch-per-unit-effort, especially if the effort is considered in terms of the cost of operating additional vessels.

From a knowledge of the maximum and current yield per recruit, (Fig.2) and given the actual yield from the fishery in the period considered, an estimate of the level of the maximum sustained yield in metric tons can be derived. These ranges are rather wide in some cases depending on the shape of the particular yield curve but for Div. 2J the range is 268-278,000 metric tons, for 3KL 343-440,000 tons, for 3NO 92-102,000 tons and for 3Ps 61-76,000 tons (Table 2). These are very similar but slightly larger than those estimated by the Assessments Subcommittee of ICNAF in 1968. Assuming the correct value of M to lie in the vicinity of 0.2 for cod in the ICNAF area (Beverton, 1965; May, 1967; Horsted, 1969), an estimate of the percentage effort change necessary to achieve maximum sustained yield in the various fisheries can be derived. For Div. 2J the present yield ($M = 0.22$) is very close to that necessary to generate the maximum sustained yield while in the other divisions a reduction of 30-50% in effort would likely result in increased yield on a long-term basis.

Discussion and conclusions

The catch-per-unit-effort and total effort figures shown in Fig.1 have not been adjusted for secular increases in fishing power of the trawler fleets. Also, the increased mobility of the fleets in recent years resulting in vessels fishing mainly in areas and seasons where the greatest catch-per-unit-effort can be obtained has not been taken into consideration. Therefore, upward trends in catch-per-unit-effort are probably overestimated and effort underestimated and the catch-per-unit-effort figures are probably not true measures of the abundance of cod in this case.

The earliest catch/effort assessment on Subareas 2 and 3 cod (Beverton, 1965) concluded that the level of fishing in 1956-58 for both 3KL and 3P cod was probably at or near that producing the maximum sustainable yield while for 3NO cod it was probably beyond the maximum. No assessment of Subarea 2 cod could be made with the available data (1956-58) at the time because of the massive increase in effort in this subarea after 1959. May (1967) concluded that the level of effort in Subarea 2 during 1963-64 was at or beyond that generating the maximum sustained yield, while a study by the Assessments Subcommittee of ICNAF (Redbook 1968, Part I) suggested that the level of fishing on all stocks in Subareas 2 and 3 was at or near that producing the maximum yield. Garrod (1969), using empirical relationships between catch-per-unit-effort and fishing effort, concluded that the level of fishing in the Northwest Atlantic is probably very close to the optimum required to secure a yield close to the potential maximum and certainly not a long way beyond this level.

Similar conclusions concerning the state of the fisheries in Subareas 2 and 3 were reached in the present study for the most recent period for which data were available. The level of fishing was probably close to or beyond that producing the maximum sustained yield. However, the level was nearer the maximum point for Subarea 2 cod than that estimated by May (1967) for 1963-64 and for Div. 3NO cod than that estimated by Beverton (1965) for 1956-58, but was further beyond the maximum point than that estimated by Beverton (1965) for 3KL and 3Ps cod during 1956-58. These differences resulted from changes in the various parameters used to construct the yield curves and in some cases from changes in F between the two periods (Table 1).

It cannot be emphasized too strongly that the conclusion drawn from catch/effort assessments are only as reliable as the estimates of the various parameters used to construct the yield curves and are only valid if the assumption of a steady, stable fishery, in which recruitment, growth, mortality, fishing effort, etc., remain constant, applies to the fishery in question. Thus if any of these factors change between periods, then new yield curves would have to be constructed and possibly different conclusions drawn. The point should also be made that the maximum yields given in this paper are maximum sustained yields and should be distinguished from the maximum yield obtainable in any one year. However, assuming a steady state condition prevails, annual yields above the maximum sustained yield could only be maintained with greatly increased effort and then not indefinitely, resulting in decreasing catch per unit effort.

The situation in 3NO is an example of this. In this area recruitment can be quite variable, the survival rate of cod in one year being many times greater or lesser than in an adjacent year. Maximum sustained yield as estimated by the Assessments Subcommittee of ICNAF in 1968 was 75,000 tons and as estimated in this paper for 1963-66 data was 92-102,000 tons. However, in 1967 the catch increased drastically to 220,000 tons and in 1968 was still 160,000 tons but had decreased to 110,000 tons in 1969 compared with about 80,000 tons in 1963-66. Associated with this was a sharp increase in effort. This resulted from increased effort on the exceptionally good 1964 year-class of cod when these fish were 3- and 4-year-old, respectively. Unless other year-classes of equal strength followed shortly after 1964, which does not seem to be the case, the level of yield will quickly return to the 1963-66 level. Since this year-class was fished at such an early age, its long-term contribution to the fishery was greatly reduced.

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Table 1. Summary of parameters used in constructing yield per recruit curves for Subareas 2 and 3 cod.

ICNAF Division	Source	Period	L_c cm	L_∞ cm	K	Z	E	M	M/K	L_c/L_∞	F/M from E/1-E
2J	Present paper	1964-68	40	81	0.15	0.7	0.64-0.79	0.15-0.25	1.00-1.67	0.49	1.8-3.8
	May (1967)	1963-64	40-45	74	0.2	0.9-1.3	0.78-0.85	0.10-0.30	0.50-1.50	0.54-0.61	3.5-5.5
3KL	Present paper	1964-68	39	114	0.11	0.7	0.64-0.79	0.15-0.25	1.36-2.27	0.34	1.8-3.8
	Beverton (1965)	1956-58	52	95-105	0.2	0.6	0.42-0.75	0.15-0.35	0.75-1.75	0.49-0.55	0.7-3.0
3NO	Present paper	1963-66	38	152	0.09	0.4-0.5	0.38-0.70	0.15-0.25	1.67-2.78	0.25	0.6-2.3
	Beverton (1965)	1956-58	40	130	0.12	0.7	0.50-0.79	0.15-0.35	1.00-2.50	(0.31)	1.0-3.8
3Ps	Present paper	1964-68	42	137	0.09	0.6	0.58-0.75	0.15-0.25	1.67-2.78	0.31	1.4-3.0
	Beverton (1965)	1956-58	46	90-100	0.2	0.6	0.42-0.75	0.15-0.35	0.75-1.75	0.46-0.51	0.7-3.0

Table 2. Calculation of maximum yields and effort changes for Subareas 2 and 3 cod stocks, 1964-68.

ICNAF Division	Z	M	F	Current Y'	Maximum Y'	1964-68 yield ('000 tons)	Maximum yield ('000 tons)	% current is of maximum	Maximum yield from 1968 Redbook	Curr F/M	Max F/M	% effort change	1969 nominal catch** ('000 tons)
2J	0.70	0.15	0.55	0.084	0.087		278	+96.6)					
		0.22	0.48	0.051	0.051	268	268	100.0)		2.18	2.33	+6.9	394
		0.26	0.44	0.040	0.041		275	-97.6)					
3KL	0.70	0.14	0.56	0.042	0.054		440	+77.7)	600				
		0.19	0.51	0.031	0.033	343	365	+93.9)		2.68	1.22	-54.5	352
		0.28	0.42	0.019	0.019		343	100.0)					
3NO*	0.45	0.14	0.31	0.032	0.037		102	+86.5					
		0.18	0.27	0.023	0.024	89	92	+95.8	75	1.50	1.00	-33.3	110
		0.27	0.18	0.011	0.012		97	-91.7					
3Ps	0.60	0.14	0.46	0.033	0.041		76	+80.5					
		0.18	0.42	0.025	0.027	61	66	+92.6	60†	2.33	1.22	-47.6	59
		0.27	0.33	0.013	0.013		61	100.0					

*1963-66

†This is obtained by considering half of the potential yield of 120 for 3P-3PN-4R as given in Redbook 1968, Part I to be applicable to 3Ps.

** These figures are provisional only, the catches for Fr(M), Fr(St.P&M) and non-member countries being based on the 1968 catches.

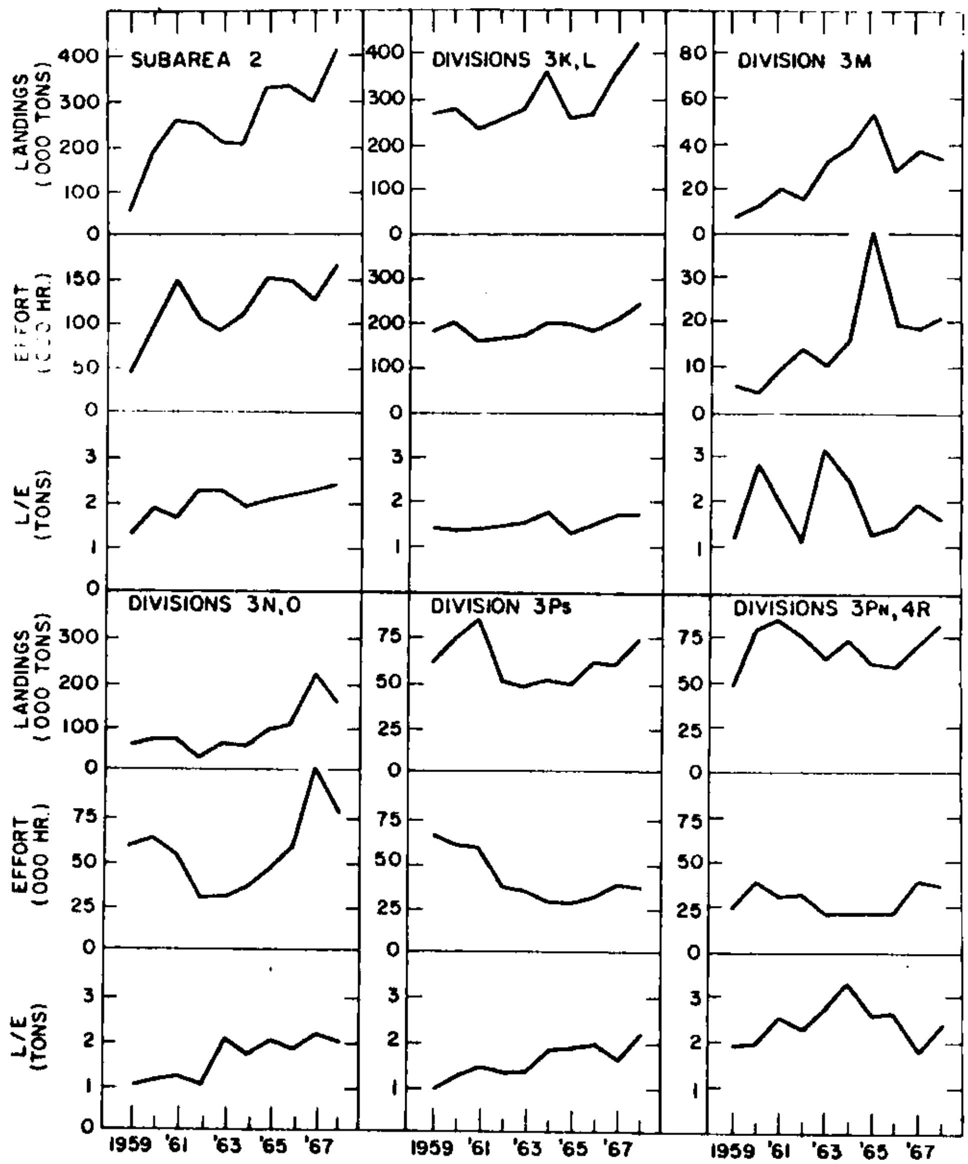

Fig. 1. Landings, effort and landings per effort for the major cod stocks in Subareas 2 and 3 and Div. 4R, 1959-68.

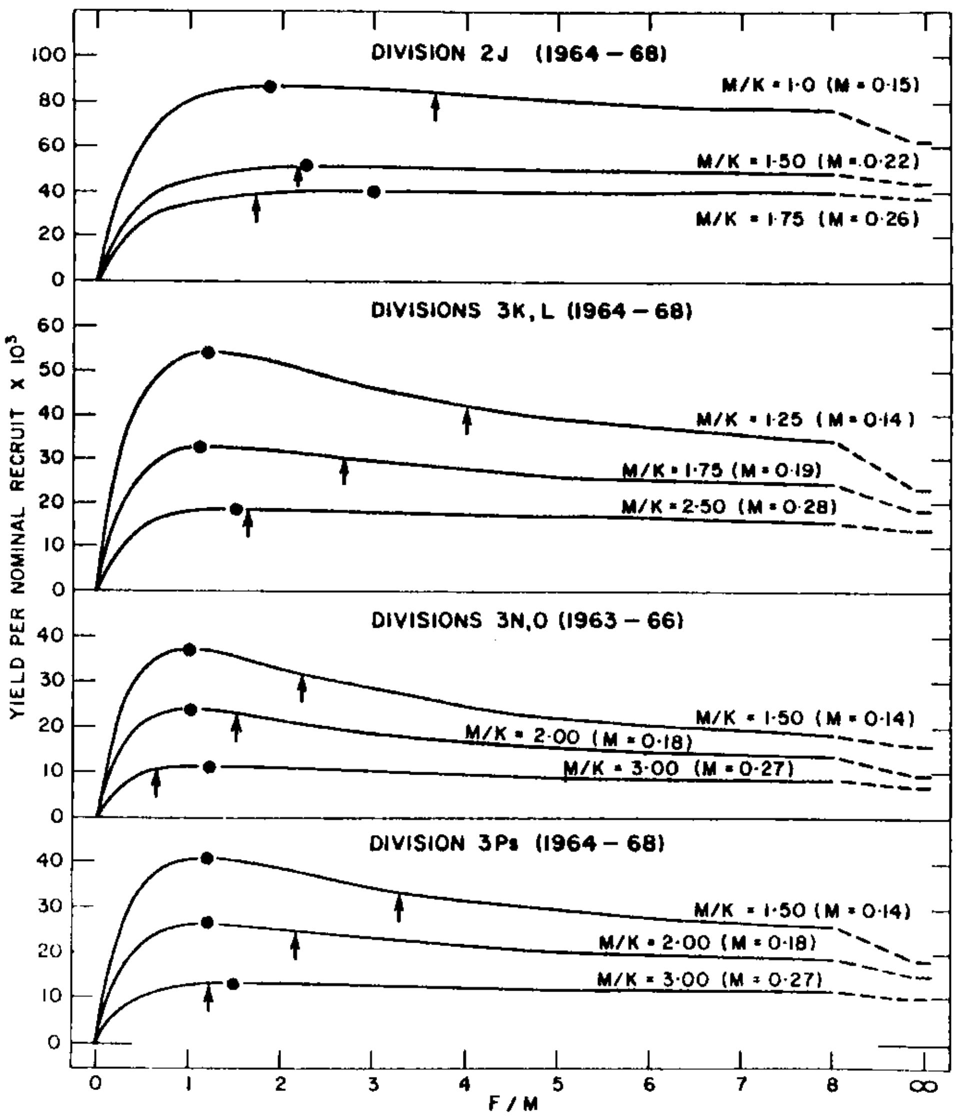

Fig. 2. Yield per recruit curves for the major cod stocks in Subareas 2 and 3. Closed circles indicate the level of fishing mortality generating the maximum sustained yield. Arrows indicate the level of fishing mortality during the period under consideration.

9. Variability in the Number of Vertebrae in Haddock from the Newfoundland Area [1]

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Based on data from tagging, age-composition and rate of growth of haddock from the New England, Nova Scotia and Newfoundland areas, Needler (1931) concluded great local groups of haddock existed in each of these areas. Further investigations (Vladykov, 1935; Schroeder, 1942; Schuck and Arnold, 1951; Martin, 1953; Clark and Vladykov, 1960; McCracken, 1963, 1965 *et al*) confirmed and made more precise this division and degree of mixing of haddock from New England and Nova Scotia.

Clark and Vladykov (1960) examined 1,230 haddock caught in 1934-1936 on St. Pierre Bank and pointed out that the Newfoundland group of haddock was characterized by a small number of vertebrae (50-56, average - 52.90[2]). According to Marr's terminology (1957) they described the mentioned populations as "stock". As data on haddock from the Grand Bank were not available they stated that the problem of the existence of local groups of haddock in the Newfoundland area was not decided finally.

Thompson (1939) pointed that there was a limited area on the Grand Bank where haddock with an average number of vertebrae from 52.5 to 52.9 form a separate stock. Based on differences in the rate of growth and abundance of year-classes, Templeman (1953) divided Grand Bank and St. Pierre Bank haddock into two separate stocks which showed no significant difference in the number of vertebrae. Simultaneously a small haddock stock with a distinctly different structure of otoliths was found on Flemish Cap Bank. Since very few big haddock on Grand Bank were caught where the growth rate was typical of the St. Pierre Bank haddock they concluded that apparently south of Green Bank an insignificant mixing of these stocks took place. Several vertebral samples from haddock caught off the southwestern coast of Newfoundland showed a small local population of haddock differing from haddock on the Grand and St. Pierre Banks by their smaller average number of vertebrae.

Further studies of otoliths, rate of growth and abundance of year-classes (Beverton and Hodder, 1962; Hodder, 1966) showed that the Grand Bank and the St. Pierre Bank haddock belonged to different stocks. It was noted

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[1] submitted to the 1970 Annual Meeting of ICNAF as ICNAF Res.Doc. 70/48.

[2] Clark and Vladykov (1960), Thompson (1939) did not take into account the last vertebra with a displaced centre and urostyle plate.

that haddock from these banks can mix at the egg, larvae and young fish stages, but at all seasons this process is greatly limited by the low water temperatures in the deeps separating these banks. However, Hodder (1966) reported that in 1949 a great amount of larvae drifted with the current from Grand Bank to St. Pierre Bank.

To provide an up-to-date picture of the structure of the population of the Newfoundland haddock we have analysed the variability in the number of vertebrae.

Material and methods

The first available sample of vertebrae from Newfoundland haddock was taken by K.P. Yanulov (PINRO) in 1961 (Appendix I). Since 1964 regular sampling was carried out. The author of this paper analysed the vertebral material directly on board the research vessels of PINRO and, like Yanulov, took into account the last vertebra with an urostyle plate. All material was combined according to areas: 1) Flemish Cap Bank (3M), 2) northeastern (3L), 3) southeastern (3N) and 4) southwestern (3O) slopes of the Grand Bank, 5) Green Bank (3P), 6) southwestern (3P) and 7) northwestern (3P) slopes of the St. Pierre Bank (Fig. 1). A total of 2,467 specimens (Appendix I) were examined. Data collected were treated mathematically according to the Snedecor method (1957).

Results of Investigations

In our samples the number of haddock vertebrae varied between 50 and 57, the average number ($\bar{x}$) being 53.57-54.60. The value of $\bar{x}$ obtained for haddock from ICNAF Div. 3O (53.82) almost completely coincides with that obtained by K.P. Yanulov (53.78) and for the areas of St. Pierre Bank (53.86 and 53.88) - with the average number of vertebrae reported by Clark and Vladykov (1960) - 52.90. For Grand Bank haddock, $\bar{x}$ in our samples fluctuates within almost the same limits as those reported by Thompson (1939). Data on the number of vertebrae in haddock from various areas are presented in Table 1.

Insignificant values of standard error of the sample ($S\bar{x}$) indicate that a sufficient number of haddock was examined in each area, with the exception of Div. 3L. Insignificant magnitudes and fluctuations of standard deviations (S) and variation coefficients (C) between areas indicate a slight variability in the number of vertebrae in haddock from the Newfoundland area. The greatest variation coefficient was obtained for haddock from Green Bank where mixing of stocks occurs.

According to the average number of vertebrae, reliable but insignificant differences (t) (Table 2) were found between haddock from the Flemish Cap Bank and other areas and also between haddock from Div. 3N and from St. Pierre Bank.

Table 1. Number of vertebrae in haddock from the Newfoundland area.

Area number	Area	Range of No. of vertebrae from - to	$\bar{x} \pm S\bar{x}$	S	C	n
1	Flemish Cap Bank (3M)	52 - 56	54.04 ± 0.09	0.83	1.54	83
2	Northeastern slope of the Grand Bank (3L)	52 - 56	53.70 ± 0.14	0.92	1.71	47
3	Southeastern slope of the Grand Bank (3N)	52 - 56	53.72 ± 0.06	0.75	1.40	188
4	Southwestern slope of the Grand Bank (3O)	51 - 57	53.82 ± 0.03	0.88	1.66	714
5	Green Bank (3P)	50 - 57	53.83 ± 0.05	0.94	1.75	330
6	Southwestern slope of the St. Pierre Bank (3P)	50 - 56	53.89 ± 0.04	0.85	1.60	546
7	Northwestern slope of the St. Pierre Bank (3P)	51 - 56	53.86 ± 0.03	0.79	1.50	559

Table 2. Mean error of the difference in the average number of vertebrae in haddock from the Newfoundland area (t)

Area number	2	3	4	5	6	7
1	2.0	2.9	2.2	1.9	1.5	2.1
2	-	0.1	0.9	0.9	1.3	1.1
3	-	-	1.4	1.4	2.4	2.0
4	-	-	-	0.2	1.4	1.0
5	-	-	-	-	0.9	0.5
6	-	-	-	-	-	0.6

More essential differences were found between $\bar{x}$ in different samples from one area (Appendix I), especially in Div.3O (t to 5.4). To ascertain the reason for these differences, the number of vertebrae in haddock belonging to the 1960-1968 year-classes was analysed (Table 3).

The average vertebral number of the 1968 year-class in Div. 3O differed greatly from that for the 1961, 1962, 1964 and 1966 year-classes (t = 5.9, 4.9, 5.0 and 3.9). Actual differences in $\bar{x}$ were also obtained between the 1966 year-class and the 1962 and 1964 year-classes (t = 2.5 and 2.1) and between the 1962 year-class and the 1964 and 1965 year-classes (t = 3.2 and 2.0) of haddock on the Green Bank. On the southwestern slope of St. Pierre Bank, the 1964 year-class differs significantly from the 1966 year-class (t = 3.6). On the northwestern slope of St. Pierre Bank the 1962 year-class differs from those of 1964, 1966 and 1967 (t = 4.1, 2.8 and 2.3) and the 1964 year-class from that of 1966 (t = 2.2).

Thus the greatest differences in the average number of vertebrae between year-classes and the greatest differences in the average number of the vertebrae in various samples were obtained for Div. 3O. Apparently it was the prevalence of a particular year-class in the sample that caused significant fluctuations in the average number of vertebrae in samples of haddock from an area. Obviously the number of vertebrae as a criterion of whether fish belong to a particular population should be considered with an allowance for variation of this character according to year-classes. It was proved that in one area fluctuation of average number of vertebrae between year-classes was due to variations in surface water temperature in the spawning period in various years (Clark and Vladykov, 1960).

Thus, the differences in the average number of vertebrae in haddock belonging to various year-classes in one area are greater than those in the average number of vertebrae of haddock in the areas mentioned making it impossible to divide haddock from the Newfoundland area into stocks according to the number of vertebrae.

Conclusions

1. Number of vertebrae in haddock from the Newfoundland area fluctuates between 50 and 57 insignificantly varying between areas. Average number of vertebrae in separate samples fluctuates from 53.57 to 54.60, as to the differences between areas reliable but insignificant differences in the average number of vertebrae were found between haddock from Flemish Cap Bank and other areas as well as between haddock from the southeastern slope of the Grand Bank (3N) and St. Pierre Bank.

2. Considerable differences were found in the average vertebral number between samples of haddock taken from the same area, especially on the southwestern slope of the Grand Bank (3O).

3. Still greater differences were found in the average number of vertebrae between year-classes of haddock from the same area. The predominance of a particular year-class in the sample causes significant fluctuations in the average number of vertebrae in samples taken from the same area.

4. In haddock samples, the differences in the average number of vertebrae are much greater between year-classes from the same area than the differences between areas, because of this, it is impossible, using vertebral numbers, to separate the haddock from the Newfoundland area into stocks with any reliability.

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Table 3. Average number of vertebrae in haddock of the 1960-1968 year-classes in the Newfoundland area. (Data from 1961 and 1964-1969).

Year Class	Southeastern slope of the Grand Bank (3N)		Southwestern slope of the Grand Bank (3O)		Green Bank (3P)		Southwestern slope of the St. Pierre Bank (3P)		Northwestern slope of the St. Pierre Bank (3P)		Total	
	n	$\bar{x}$	n	$\bar{x}$	n	$\bar{x}$	n	$\bar{x}$	n	$\bar{x}$	n	$\bar{x}$
1960	5	53.74	13	53.69	3	54.00	8	53.75	8	54.37	37	53.95
1961	33	53.57	80	53.71	11	53.18	32	53.88	26	53.81	182	53.70
1962	105	53.77	292	53.72	44	54.25	70	53.89	32	54.22	543	53.82
1963	9	53.89	26	53.85	20	53.70	77	53.87	16	53.81	148	53.84
1964	26	53.73	38	53.66	153	53.79	132	53.76	113	53.66	462	53.73
1965	1	54.00	10	54.10	32	53.69	5	53.00	17	53.65	65	53.69
1966			95	54.02	61	53.95	162	54.10	215	53.81	533	53.95
1967			8	53.75	2	54.50	27	53.63	71	53.85	108	53.80
1968			31	54.65	3	54.00	4	55.75	3	54.67	41	54.71
Total	179	53.74	593	53.81	329	53.85	517	53.91	501	53.82	2119	53.84

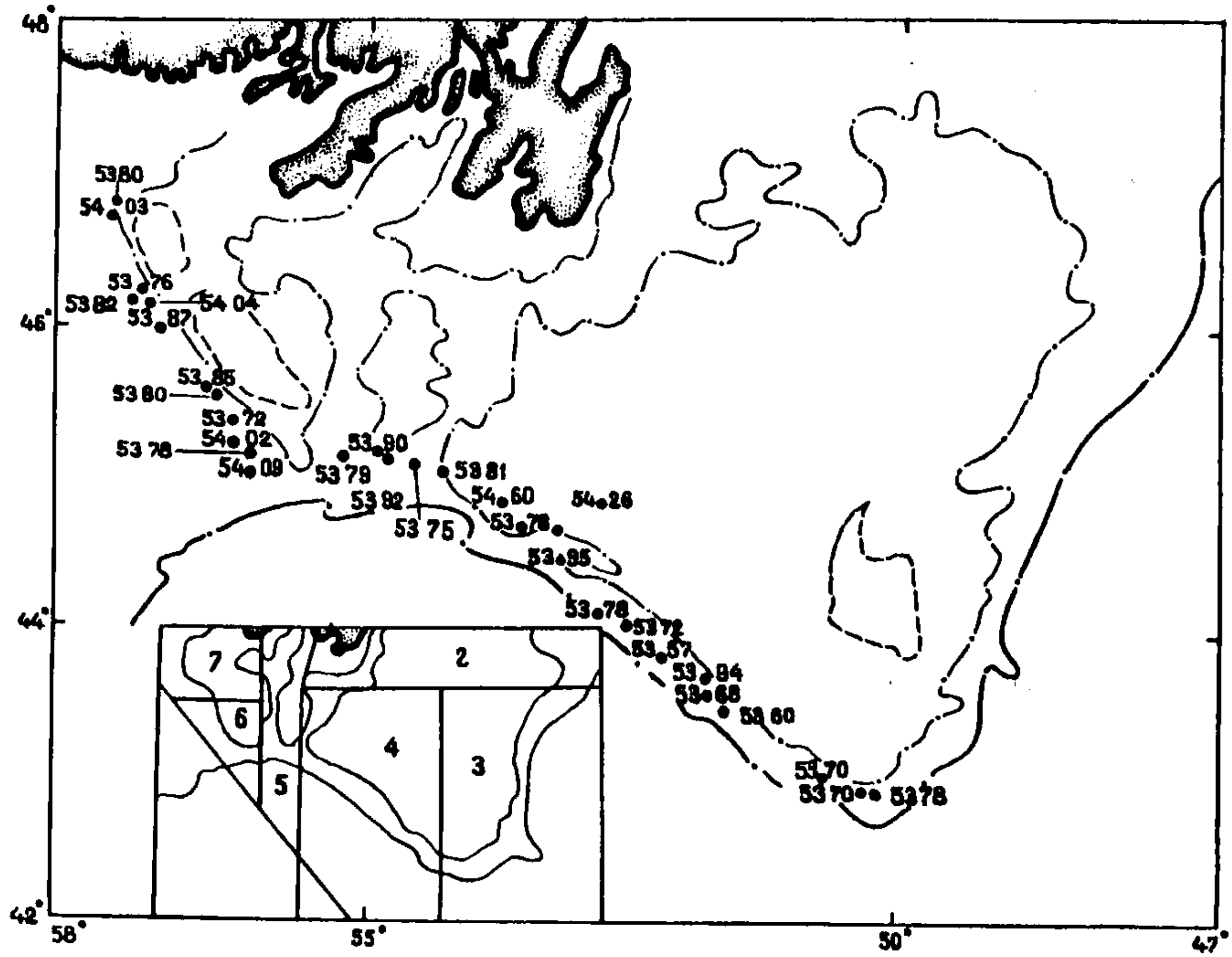

Fig. 1. Average number of vertebrae in haddock from the Newfoundland area. (Data from 1961 and 1964-1969).

Description of numbered areas on insert map:

2. Northeast slope of Grand Bank (Div.3L);
3. Southeast slope of Grand Bank (Div.3N);
4. Southwest slope of Grand Bank (Div.3O);
5. Green Bank (Div.3P);
6. Southwest slope of St. Pierre Bank (Div.3P);
7. Northwest slope of St. Pierre Bank (Div.3P).

Area and date		number of fish with total amount of vertebrae								total number of fish	average number of vertebrae
		50	5I	52	53	54	55	56	57		
3M, Flemish Cap Bank											
April	I967			I	5	8	2	I		I7	53,82
April	I968			I	4	I0	5	I		2I	54,05
April	I969				9	23	I2	I		45	54,II
total by the area				2	I8	4I	I9	3		83	54,04
Grand Bank 3L, north-eastern slope											
March	I967			2	22	I2	I0	I		47	53,70
3N, south-eastern slope											
February	I966			I	I4	30	5			50	53,78
April	I967			4	9	I8	6			37	53,70
April	I967			5	32	53	I0	I		I0I	53,70
total by the area				I0	55	I0I	2I	I		I88	53,72
30 south-western slope											
May	I96I x/			4	39	36	I7	4		I00	53,78
December	I964			6	38	40	I5		I	I00	53,68
October	I965		I	2	2I	I9	7			50	53,57
February	I966			2	2I	I5	I0	2		50	53,78
February	I966		I	2	20	20	7			50	53,60
May	I966		I	I	30	53	I4	I		I00	53,8I
April	I967				9	I6	7			32	53,94
May	I967		I	3	26	29	I3	I		73	53,72
May	I968			2	3I	43	I9	4	I	I00	53,95
May	I969				4	I7	I3			34	54,26
May	I969				I	I0	I2	2		25	54,60
total by the area			4	22	240	298	I34	I4	2	7I4	53,82

x/ The analysis was made by Yanulov K.P.

Area and date		number of fish with total amount of vertebrae								total number of fish	average number of vertebrae
		50	5I	52	53	54	55	56	57		
3P Green Bank											
April	I967	I		II	24	45	I4	4	I	I00	53,75
April	I967			4	30	5I	I3	2		I00	53,79
May	I968		2	2	26	44	22	3		99	53,92
June	I969		I	I	4	I9	6			3I	53,90
total by the area		I	3	I8	84	I59	55	9	I	330	53,82
3P. Saint Pierre Bank											
a/ south-western slope											
October	I965	I	I	3	I4	20	9	2		50	53,72
May	I966			2	32	5I	I4	I		I00	53,80
April	I967		I	I	32	5I	II	2		98	53,78
April	I967			4	30	45	I5	4		98	53,85
June	I968			5	I9	53	2I	2		I00	54,02
June	I969			4	I5	54	22	5		I00	54,09
total by the area		I	2	I9	I42	274	92	I6		546	53,88
b/ north-western slope											
May	I966			2	24	44	28	2		I00	54,04
April	I967			5	30	50	I4	I		I00	53,76
June	I968			5	3I	5I	I3			I00	53,72
June	I968			6	24	52	I8			I00	53,80
June	I969			4	24	57	I6			I0I	53,87
June	I969		I	I	9	32	I4	I		58	54,03
total by the area			I	23	I42	286	I03	4		559	53,86

10. 4T-V-W Haddock : Recruitment and Stock Abundance in 1970-72[1]

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Introduction

Marked declines in the abundance of, and yield from, the haddock stock of the eastern Scotian Shelf and southern Gulf of St. Lawrence (ICNAF Div. 4T-V-W) necessitate consideration of further regulation of this fishery (Report of the Interim Meeting of the Assessments Subcommittee, ICNAF Comm. Doc. 70/3). An assessment of this stock is presented by Halliday (ICNAF Res. Doc. 70/74). The present document provides estimates of the abundance of the 1966-68 year-classes which will be recruited in 1970-72, and predicts the abundance of the exploited population in these years.

Data on which to predict the strength of recent year-classes are limited to those obtained on a single Canadian research vessel cruise prosecuted in 4W in July 1969. This cruise was specifically designed to quantitatively survey groundfish stocks, particularly juvenile haddock. It will, of course, be several years before the usefulness of predictions from this and subsequent cruises can be adequately evaluated. However, as predictions are required now, a cursory evaluation is carried out using pre-1969 surveys designed for other purposes. The preliminary nature of these results probably requires no further emphasis.

Material and methods

Dr Frank McCracken undertook three cruises in 4V-W in the summers of 1958-60 to investigate haddock distribution. He found that small haddock ages 1-4 are concentrated on the offshore banks, mainly Sable Island Bank, at that time of year (McCracken, 1965). The results of these three cruises are used here to estimate the abundance of the 1954-59 haddock year-classes at ages 1-3, and investigate the relationship to subsequent abundance in the commercial fishery.

In the light of McCracken's results, the area considered in the following calculations is restricted to offshore 4W - specifically strata 52-55, 60-64 inclusive (Fig.1). These strata form part of a preliminary stratification of the Nova Scotia banks agreed upon by Canadian, Soviet, and US scientists for use in multi-national groundfish surveys (Grosslein, ICNAF Res. Doc.70/80). The area covered by these strata (Table 1), calculated from large-scale fishing charts, is about 9,700 square nautical miles.

[1] submitted to the 1970 Annual Meeting of ICNAF as ICNAF Res.Doc.70/75.

The 1969 survey procedure was similar to that of recent USA-USSR joint groundfish surveys, involving fishing at randomly pre-selected stations within strata, and is described and justified by Grosslein (ICNAF Res.Doc. 68/87). In contrast, on the 1958-60 cruises, stations were not randomly selected, and frequently several tows were made at the same location. However, broad coverage of the area was a major objective of the cruises, and each stratum contains at least one fishing station with the exception of stratum 64 in 1958 (Table 1). To reduce bias due to non-random station selection, repeat tows are not considered in this analysis. A repeat tow is arbitrarily defined as one starting less than 4 minutes of latitude or longitude from a previous tow, unless the average depth fished in the two tows differed by 5 fathoms or more.

Table 1. Strata areas and coverage by Canadian research vessel surveys.

Vessel Date Gear	*Harengus* Aug-Sep '58 #36 Manilla	*Harengus* July '59 #36 Manilla	*Harengus* July '60 #36 Manilla	*EE Prince* July '67 #41 Poly-ethylene	*EE Prince* July '69 #36 Poly-thylene
Trawl mouth opening(feet)	35	35	35	45	35
Towing speed (knots)	3.0	3.0	3.0	3.5	3.5

Stratum	Area (sq. naut. miles)	Number of tows				
52	1,837	3	6	3	2	7
53	2,002	5	9	6	5	13
54	257	6	1	1	1	2
55	1,093	4	5	5	7	6
60	584	1	2	3	1	4
61	873	1	7	2	2	3
62	831	9	6	8	10	5
63	1,779	5	8	10	11	9
64	448	-	5	2	-	4
Total	9,704	34	49	40	39	53

The 1958-60 surveys were made by the M/V *Harengus*, a 78 ft side trawler, using a #36 yankee manilla otter trawl. The 1969 survey was made by the C.G.S. *E.E. Prince*, a 130 ft stern trawler, using a #36 yankee polyehtylene otter trawl. Both trawls had 1 1/4" codend liners or covers. No comparative fishing experiments for haddock have been conducted with these vessels. Comparative fishing for cod shows catches are comparable in numbers and length-frequency distribution when allowance is made for differences in distances travelled (Kohler, MS, 1969). It is assumed here, that the two vessels are also comparable in their ability to catch haddock.

Area of seabed swept by each tow is taken as the product of the width between the trawl wings and the distance travelled. Carrothers *et al.* (MS, 1969) indicate that the wing spread of a #36 yankee polyethylene trawl towed by the *Harengus* at 3.0 knots (the vessel's normal towing speed) is 35 ft. No gear behaviour studies have been conducted on the *E.E. Prince* but it is assumed that the wing spread of its #36 trawl is also 35 ft. Normal towing speed of the *E.E. Prince* is 3.5 knots. On the 1958 *Harengus* cruise, tows were mainly of 45 minutes duration. In subsequent cruises they were almost all of 30 minutes duration.

Total number of haddock and their length frequency distribution were recorded for each catch, or were estimated from subsamples when the catch was very large. On each survey a sample of 500-1000 otoliths was collected for age determination.

An estimate of the total number of haddock present in each stratum, and by summation, the total number in the whole area, in each year, is calculated by simple proportion:

$$\text{total number} = \text{number caught} \times \frac{\text{total area}}{\text{area swept}}$$

A single age-length key for the whole area is applied to the combined length-frequency distributions of all tows in a stratum, to provide the age distribution of the haddock in that stratum. Estimates of numbers of haddock of each age-group in each stratum are obtained by prorating the estimates of total numbers in the stratum by the appropriate age distribution. Total numbers of haddock of each age in the whole area, are the sums of the numbers in each stratum.

In July 1967 McCracken undertook a survey in 4W to investigate the distribution and abundance of juvenile haddock. The vessel used, the *E.E. Prince* was at that time equipped with a #41 yankee polyethylene otter trawl. Doubts as to the ability of the *E.E. Prince* to fish this gear efficiently resulted in a change to the smaller #36 yankee trawl after the first year of the vessel's operation (1967). Thus, less confidence can be placed in the quantitative results of the 1967 survey and these are presented with reservations. Data treatment is identical to that for 1958-60 cruises. Wing spread is taken as 45 ft, from data of Carrothers *et al.* (MS.1969) for the #41 yankee trawl fished by other vessels.

Haddock from this stock normally make their first contribution to landings at age 3, becoming fully recruited to otter trawls using regulation 4 1/2-inch mesh at age 6. (This is almost entirely an otter trawl fishery.) In the following analysis estimates of partial recruitment of age-groups 3-5 are required. These are obtained by the method of Horsted and Garrod (1969) using 1958-61 Canadian commercial sampling data and adjusting these to represent total landings. The method involves calculating the numerical abundance (N) of each age-group at the beginning of each year, using a single value of F (instantaneous fishing mortality) for all age-groups. Values of F used in this and other calculations are derived from the equation:

$$F = qf$$

where f is effective fishing effort (total catch/Canadian catch per unit effort) and q = 0.000 009 068 from the regression of instantaneous total mortality (Z) on fishing effort (Halliday, ICNAF Res. Doc. 70/74). Estimates of N for each age-group are made in two ways:

(1) as the survivors of the stock in year $i-1$, from the equation:

$$N_i = N_{i-1} e^{-Z_{i-1}} \qquad \text{equation 1}$$

(2) as the number of fish at the beginning of the year i necessary to generate the catch (C) in that year, from the equation:

$$N_i = \frac{C_i Z_i}{F_i (1-e^{-Z_i})} \qquad \text{equation 2}$$

The difference between these estimates represents the number of new recruits entering the age-group, and the ratio between this and the number in the stock of the year-class at the beginning of year $i-1$ measures the new recruits as a proportion of the previous stock of that year-class. The 1958-61 haddock give three observations for each pair of age-groups and the mean of these is used to calculate partial recruitment values as described in the following results section.

Results

Partial Recruitment Values

Investigation of partial recruitment by the method of Horsted and Garrod confirms previous conclusions that year-classes are fully recruited to this fishery at age 6, as new recruits as a proportion of previous stock approximates zero at age-groups 7/6 (Table 2). New recruits at age 6 (R_6) to the stock at age 5 (N_5) is 0.2447. Therefore:

$$R_6 = 0.2447 N_5$$

Also $$N_5 + R_6 = N_6$$

therefore $$N_5 + 0.2447 N_5 = N_6$$

and $$N_5 = N_6 / 1.2447$$

Taking $N_6 = 1$, signifying full recruitment,

then $N_5 = 0.80$

i.e. haddock at age 5 are 80% recruited to the fishery. Similarly, partial recruitment indices are calculated for age 4 = 0.41, and age 3 = 0.06. These values indicate that 50% recruitment occurs at approximately 4.2 years, close to the independent estimate of 3.8 years from net characteristics of the Canadian fleet (Halliday, ICNAF Res. Doc. 70/74).

TABLE 2. New recruits as a proportion of the stock of the same year-class one year earlier. (Means calculated diagonally.)

Year-class	Calendar years: 1959/58	1960/59	1961/60	Mean	Age-groups in ratio
1949	neg.				
1950	neg.	.0510			
1951	neg.	.9379	.1155	-	10/9
1952	neg.	.0541	.0155	-	9/8
1953	.4704	.5112	.0478	-	8/7
1954	1.2036	.1050	neg.	-	7/6
1955	3.6667	.5711	.1588	.2447	6/5
1956		1.0423	1.0504	.9417	5/4
1957			14.3126	6.3405	4/3

Recruitment Predictions

The 1958-60 surveys give estimates of total numbers of haddock of the 1954-59 year-classes at various ages between 1 and 4 (Table 3). The 1956 and 1957 year-classes were the most abundant, and that of 1958 least abundant, of the six. Survival of year-classes between ages 1 and 2, and 2 and 3, was about 78%, and between ages 3 and 4, about 62% (Table 4).

Table 3. Estimated total numbers of haddock of the 1954-59 year-classes in the survey area in the summers of 1958-60.

YEAR	YEAR-CLASS 1954	1955	1956	1957	1958	1959
1958	6,032,000	10,027,000	39,375,000	25,253,000	-	-
1959	-	6,379,000	30,680,000	27,047,000	3,825,000	-
1960	-	-	18,281,000	21,743,000	1,810,000	9,777,000
Age (diagonally)			4	3	2	1

Table 4. Survival of 1955-58 year-classes at ages between 1 and 4 from estimates of abundance in the survey area in successive years.

Year-class	Survival (%) Age 1-2	Age 2-3	Age 3-4
1958	47	-	-
1957	107	80	-
1956	-	78	60
1955	-	-	64

In those years haddock ages 1 and 2 were probably not subject to any significant fishing mortality, and 3 year-olds were only 6% recruited to the fishery. Thus, mortality between ages 1 and 2, and 2 and 3, is an estimate of natural mortality, $M = 0.25$. This is close to the estimate of $M = 0.20$ obtained by regression of total mortality on effective fishing effort (Halliday, Res. Doc. 70/74). The estimate of total mortality $Z = 0.48$ between ages 3 and 4 thus suggests that fishing mortality, $F = 0.23$. In 1959 and 1960, F on fully recruited age-groups was about 0.75, giving an independent estimate of $F = 0.30$ on age 4, close to that obtained from the surveys.

The strengths of the 1954-59 year-classes are difficult to compare with their later abundance in the commercial fishery as they are based on 1, 2, or 3 estimates at different ages between 1 and 4. Thus abundance of each year-class at ages 1-3 is calculated (where not observed directly) from the direct observations and the survival rates presented above (Table 5). Using both observed and calculated abundance at ages 1-3, the mean abundance at these ages is obtained, thus putting all 6 estimates of year-class strength on a comparable basis.

The first significant contribution to the commercial catch is made at age 4 - this age-group contributing, on average, about 20% of the catch by numbers and 15% by weight. Thus recruitment predictions can perhaps most usefully be given as estimated population numbers at age 4.

Estimates of the total numbers of haddock landed at age 4 from the year-classes 1954-59 is obtained by prorating total landings using Canadian catch statistics. Estimates of initial population at age 4 is then obtained from equation 2 (Table 5).

The relationship of mean abundance at ages 1-3 (X) estimated from survey cruises to abundance at age 4 (Y) from commercial data is adequately described by a logarithmic transformation of the equation:

$$Y = a X^{b}$$

giving $\log_e Y = 1.4457 + 0.5785 \log_e X$

where units are expressed as millions of haddock (Fig. 2).

The transformed data have a significant correlation coefficient $= 0.830$ ($P_{0.05} = 0.811$).

Abundance estimates of 1963-68 year-classes at ages between 1 and 4 from 1967 and 1969 surveys are low, varying between 1.1 and 6.4 million fish (Table 6). However, abundance estimates of the 1966 and 1965 year-classes at ages 1 and 2 are considerably less than their respective abundances at ages 3 and 4. This confirms doubts about gear efficiency on the 1967 cruise, and 1967 data are not considered further. The 1969 abundance estimates of the 1966-68 year-classes are adjusted, again using a rate of survival of 0.78, to give mean abundance estimates at ages 1-3 (Table 7). Abundance at age 4 is estimated graphically from Fig. 2 giving 14.5 million recruits in 1970 (1966 year-class), 9 million in 1971 (1967 year-class), and 5.5 million in 1972 (1968 year-class).

TABLE 5. Abundance of the 1954–59 year-classes at ages 1–3 and mean abundance, estimated from survey cruises, and abundance at age 4 estimated from commercial statistics. (Asterisks denote values calculated using survival rates, S.)

AGE	S	YEAR – CLASS 1954	1955	1956	1957	1958	1959
1	.78	15,991,000*	16,481,000*	50,481,000*	25,253,000	3,825,000	9,777,000
2	.78	12,473,000*	12,855,000*	39,375,000	27,047,000	1,810,000	7,626,000*
3	.62	9,729,000*	10,027,000	30,680,000	21,743,000	1,412,000*	5,948,000*
4		6,032,000	-	-	-	-	-
MEAN OF AGES 1–3		12,700,000	13,100,000	40,200,000	24,700,000	2,300,000	7,800,000
ABUNDANCE AT AGE 4 (FROM COMMERCIAL STATISTICS)		16,900,000	38,500,000	30,900,000	19,500,000	5,400,000	15,600,000

Table 6. Estimated total numbers of haddock of the 1963-68 year-classes in the survey area in the summers of 1967 and 1969.

	Year-class					
Year	1963	1964	1965	1966	1967	1968
1967	3,112,000	2,396,000	1,106,000	1,621,000	-	-
1969	-	-	5,536,000	6,371,000	3,717,000	1,878,000

Table 7. Abundance of the 1966-68 year-classes at ages 1-3 and mean abundance, estimated from survey cruises, and abundance at age 4 estimated from Fig. 2. (Asterisks denote values calculated using a survival rate of 0.78).

	Year-class		
Age	1966	1967	1968
1	10,472,000*	4,765,000*	1,878,000
2	8,168,000*	3,717,000	1,465,000*
3	6,371,000	2,899,000*	1,143,000*
Mean of ages 1-3	8,300,000	3,800,000	1,500,000
Estimated abundance age 4	14,500,000	9,000,000	5,500,000

Recent Stock Abundance and Abundance Predictions

Total haddock landings from 4T-V-W in 1967 were 10,912 metric tons (ICNAF Stat.Bull. Vol. 17, 1969), in 1968, 13,309 metric tons (ICNAF Res. Doc. 69/21), Canada landing approximately 75% of the total in each year. Canadian landings in 1969 were 9,305 metric tons. Assuming Canada also landed about 75% of the 1969 catch, total landings were approximately 12,000 metric tons. Applying Canadian catch composition data to total landings, allows these yields to be expressed in numbers of fish, 8 million, 9.4 million, and 7.9 million, haddock being landed in 1967-69 respectively. Using equations 1 and 2, the state of the stock in 1967-69 is portrayed in terms of available population, removals, and recruits (Table 8). Available population declined between 1967-69 from 33 million to 25 million fish, landings were stable at approximately 12,000 metric tons, while F increased from 0.47-0.59.

The state of the stock in 1970-72 depends not only on the abundance of recruits, but on the fishing mortality exerted. Assuming F is 0.50, the value giving maximum sustainable yield under stable conditions, the population may increase slightly to 28 million fish in 1970, and decline to 20 million in 1972. Landings will be approximately 9,000-9,500 metric tons (Table 8).

Table 8. 4T-V-W haddock: available population, removals, recruits, fishing mortality (F), and yield, 1967-72.

	Calendar Year					
	1967	1968	1969	1970	1971	1972
Available popn. x 10^{-6}	33.0	30.5	25.0	27.8	25.6	20.3
Removals x 10^{-6}						
Total	13.2	14.0	11.6	11.2	10.8	9.0
Fishing	8.0	9.4	7.9	6.9	6.9	5.9
Natural	5.2	4.6	3.7	4.3	3.9	3.1
Recruits at age 4 x 10^{-6}	10.0	8.5	14.5	9.0	5.5	?
Fishing mortality F	0.47	0.57	0.59	0.50	0.50	0.50
Landings metric tons	11,000	13,500	12,000	9,500	9,500	9,000

Discussion

Even at the low levels of stock abundance prevailing in 1967-69, fishing mortality remained high. In 1970-72 recruitment will continue to be poor and it is likely that fishing mortality will remain at least as high as 0.50, possibly higher. Thus, it appears likely that stock abundance will show a further substantial decline by 1972, unless further regulatory measures are enforced. Obviously, the most rapid recovery of the stock would be effected through complete cessation of fishing. A catch quota designed to prevent a further stock decline below 1967-69 levels, would necessarily have to be less than 9,000 metric tons.

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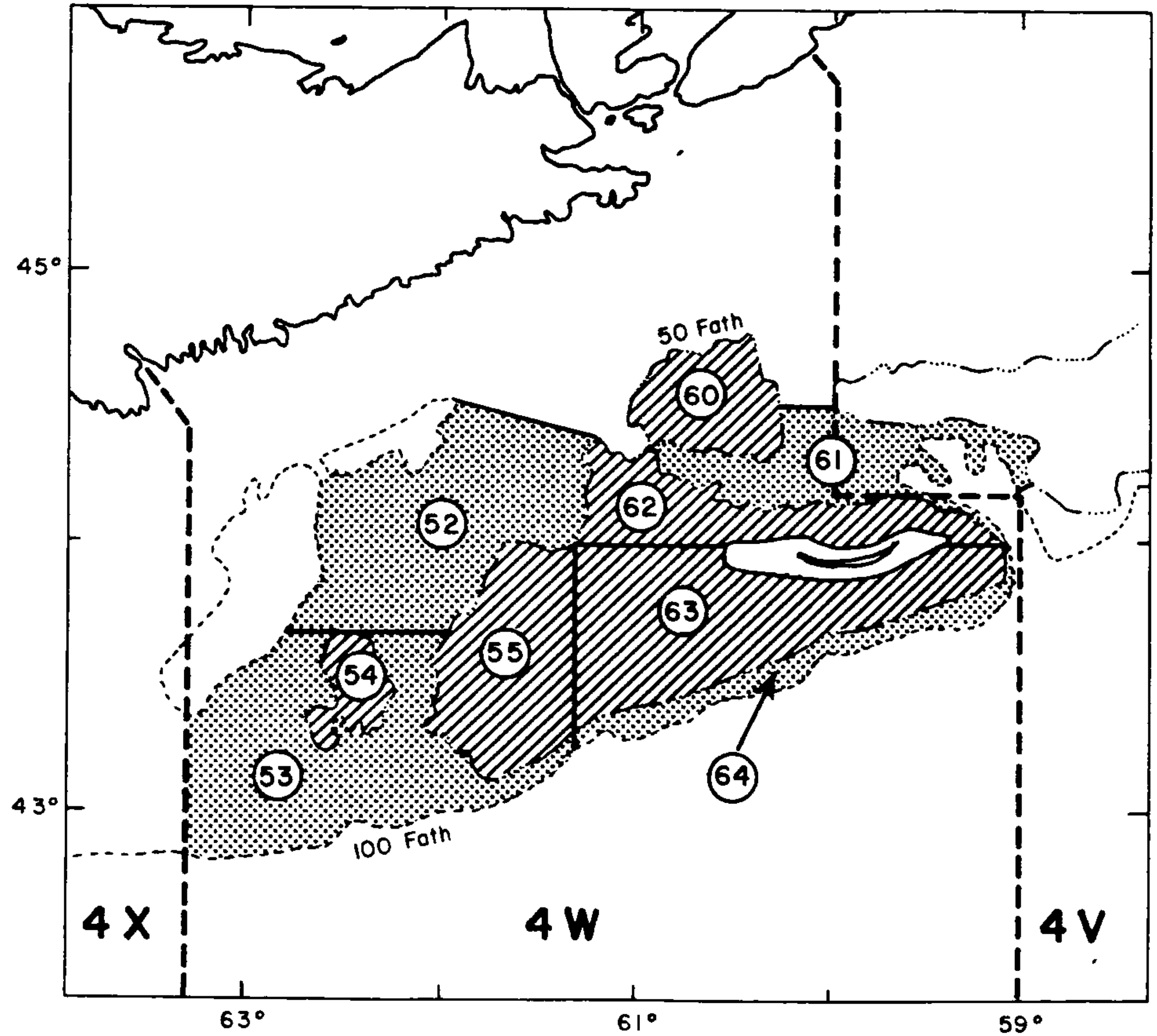

Fig. 1. ICNAF Div. 4W showing strata 52-55, 60-64, used to calculate juvenile haddock abundance.

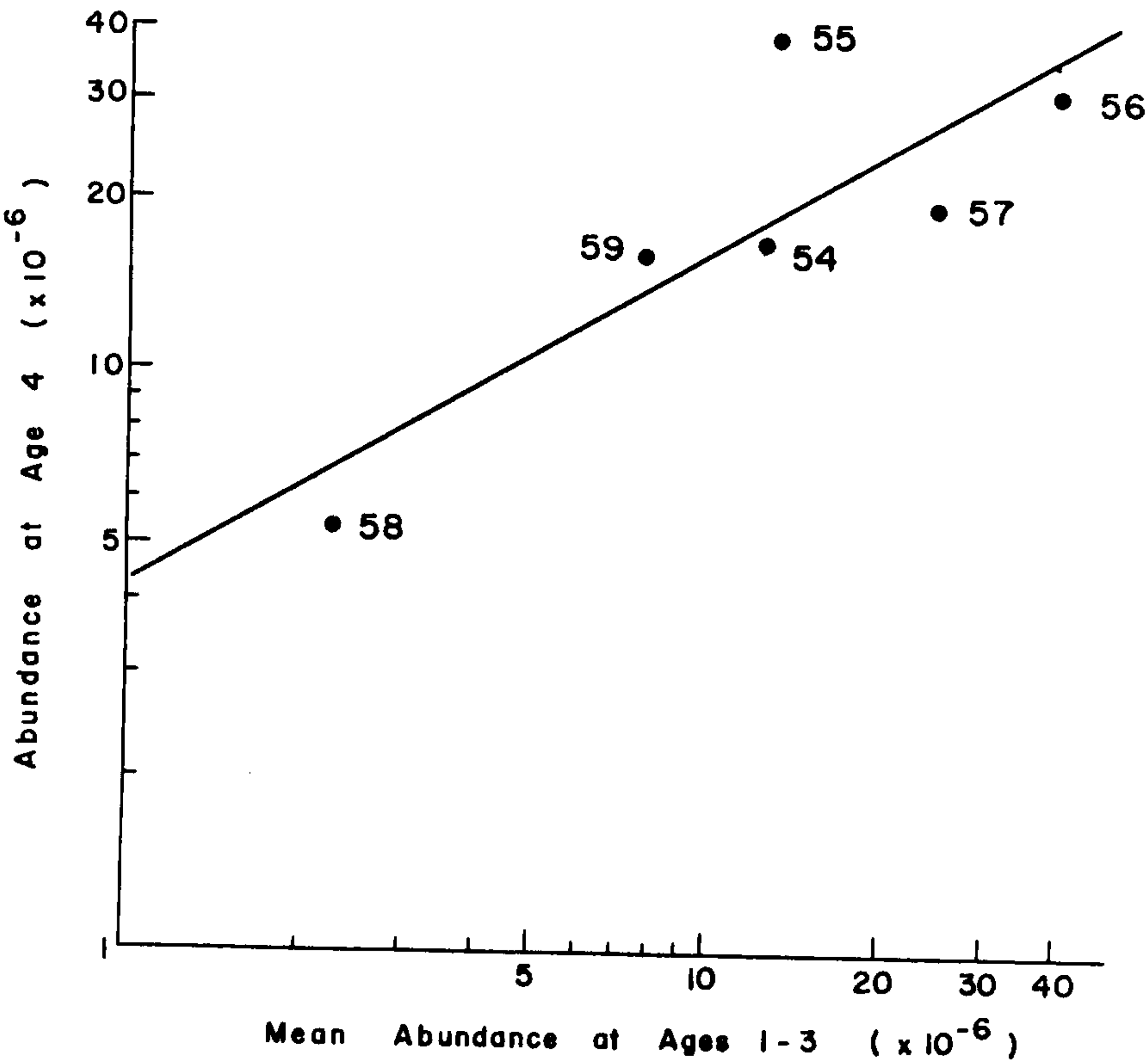

Fig. 2. Relationship of mean abundance at ages 1-3 estimated from survey cruises to abundance at age 4 from commercial statistics for the 1954-59 year-classes.

11. The Number of Haddock Spawning on Georges Bank as estimated from Egg Surveys[1]

by J.A. Posgay and R.R. Marak
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During the spring of 1968 we conducted a series of seven cruises to Georges Bank in an attempt to establish an egg production curve for haddock, *Melanogrammus aeglefinus*. The area selected for sampling (Fig. 1) had been defined as the major, up to 80%, haddock spawning ground in Subarea 5 by Hardy Recorder surveys some years ago and more recent samplings of the commercial landings for spent and spawning fish. On each cruise 50 stations were occupied using a stratified random sampling design with 16 stations in Stratum 1, 12 stations in Stratum 2, 12 stations in Stratum 3, and 10 stations in Stratum 4.

Each station consisted of a BT cast to the bottom and a 15-minute, 5-step oblique haul from 50 meters depth to the surface at 3.5 knots (108 m/minute). The sampler was our smaller bongo (diameter 21 cm) with nets of #505 NITEX and a four-foot, V-FIN depressor. Since early stage haddock eggs cannot be reliably separated from those of cod, *Gadus morhua*, the cod-haddock eggs were immediately picked out of the catch of the starboard net and put in hatching jars. After these eggs hatched into identifiable larvae they were preserved and used to calculate a cod/haddock egg ratio. The catch of the port net was preserved.

Ashore, all of the cod-haddock eggs were picked from the catch of the port net and sorted into six developmental stages (Marak and Colton, 1961). The cod/haddock ratio from the hatched eggs was then applied to estimate the number of haddock eggs at each stage. Table 1 shows the arithmetic mean catch per cubic meter for Stage I and Stages I-VI by cruise and by stratum.

From Table 1 it is apparent that almost all the eggs were spawned between 3 April and 9 May in Strata 2 and 3. The few Stage I eggs that were found in Strata I and 4 may have been transported there from the shallower strata by the strong tidal currents which occur in the area. A plot of the stations and catches on the most successful cruise, that of 18 April (Fig. 2) shows that all but four of those hauls that took any Stage I eggs were inside the 50-fathom (91 m) isobath. The concentration of the higher catches in the southwestern part of the sampling area suggests that there may have been some haddock spawning to the south and west. If so, the Stage I eggs from these fish would not appear in our collection and our estimate of spawning stock size would be low.

1 submitted to the 1970 Annual Meeting of ICNAF as ICNAF Res. Doc. 70/83

Table 1. Mean numbers of Stage I and Stages I-VI haddock eggs taken per cubic meter filtered by stratum and cruise.

Stratum	1		2		3		4	
Stage	I	I-VI	I	I-VI	I	I-VI	I	I-VI
Date								
1 March	.000	.000	.000	.000	.000	.002	.000	.000
20 March	.000	.000	.000	.008	.007	.241	.000	.015
3 April	.000	.000	.034	.134	.181	.984	.004	.013
18 April	.000	.008	.343	1.144	.701	3.230	.058	.258
9 May	.019	.581	.071	.829	.172	1.952	.000	.091
24 May	.004	.138	.040	.614	.000	.363	.000	.167
5 June	.019	.056	.047	.386	.004	.108	.000	.047

Estimate using catches of Stage I eggs

Our estimate of the total number of eggs present in the sampling area at the time of each cruise was calculated by multiplying the area of each stratum by the sampling depth (50 m) and then by the arithmetic mean catch per cubic meter and summing the four strata.

According to Walford (1938) it takes about seven days for a haddock egg to develop through Stage I at 3.0°C but only four days at 6.0°C. We used his graph of incubation period against temperature to convert the number of eggs present during any one cruise into an estimate of the mean number of eggs produced per day during the time immediately preceding the cruise. To illustrate: the estimate for the number of eggs present during the fourth cruise, 18 April, is 112.0 x 10^9 (Table 2). These eggs had developed in an average water temperature of 4.3°C and so required an incubation period of 5.5 days. Dividing number of eggs by number of days gives 20.4 x 10^9 as the average number of eggs produced per day during the five or 6 days preceding 18 April. The spawning date was then taken as 15 April, three days before the collection. The data and results for each cruise are shown in Table 2.

In order to calculate the total number of eggs produced during the entire spawning season we plotted the average number of eggs produced per day against the spawning date (Fig. 3). Assuming a smooth curve with a single peak, we fitted a curve to the points by eye and integrated the area under the curve. This gives an estimate of 575 x 10^9 eggs.

To estimate the number of female haddock that would be required to produce this many eggs we used the age 3+ length composition of the April landings from Subarea 5 and the fecundity data of Earll (1880). Very few of the age two fish are mature, but almost all of the age three spawn. This gave us 428 x 10^3 as the average number of eggs produced per female during the 1968 spawning season. Dividing total number of eggs produced by average number per female gives 1.3 x 10^6 as the number of spawning females.

Samples of haddock collected at the ports showed an approximately equal sex ratio so our estimate of the total number of fish spawning in the samples area is 2.6 x 10^6.

Table 2. The estimated number of Stage I eggs in the sampling area, the average temperature for incubation, the incubation period (I.P.) at that temperature, the mean number of eggs spawned per day during the period (E/D) and the mean date of the spawning (S.D.) for each cruise.

Date	No. of Eggs x 10^9	Temp. °C	I.P. Days	E/D x 10^9	S.D.
1 March	0.0	2.8	7.2	-	-
20 March	1.4	2.8	7.2	0.2	16 March
3 April	22.4	3.5	6.2	3.6	31 March
18 April	112.0	4.3	5.5	20.4	15 April
9 May	27.7	5.1	4.7	5.9	7 May
24 May	4.7	6.0	4.0	1.2	22 May
5 June	7.9	7.1	3.2	2.5	3 June

Estimate using all stages of eggs

The effects of dispersion and mortality should act to reduce the number of later stage eggs in the water directly over the spawning ground. We have no data which would allow us to compensate for these factors. Walford (1938) also gives a graph of incubation period as a function of temperature through all egg stages to hatching. Using the same methods described above for the Stage I eggs, we calculated an estimate of spawning stock size from the catches of all stages of eggs (Table 3, Fig. 4). This gives us 5.0 x 10^6 as the size of the spawning stock.

Table 3. The estimated number of all stages of haddock eggs in the sampling area, the average temperature during incubation, the incubation period (I.P.) at that temperature, the mean number of eggs spawned per day during the period (E/D), and the mean date of the spawning for each cruise.

Date	No. of Eggs x 10^9	Temp. °C	I.P. Days	E/D x 10^9	S.D.
1 March	0.2	2.8	24	0.0	-
20 March	26.8	2.8	24	1.1	8 March
3 April	116.1	3.2	23	5.0	22 March
18 April	471.5	4.0	21	22.5	8 April
9 May	375.9	4.9	19	19.8	30 April
24 May	133.1	5.6	18	7.4	15 May
5 June	62.5	6.4	16	3.9	28 May

Comparison with other methods

The Report of the Interim Meeting of the Assessment Subcommittee (ICNAF Comm. Doc. 70/3) states that there were about 46 x 10^6 age 3+ haddock available in all of Subarea 5 in 1968. In the same document there is another estimate, calculated from the catches on research vessel surveys that there were about 16 x 10^6 mature haddock on Georges Bank in the spring of 1968. Removals of age 3+ haddock from all of Subarea 5 are estimated as 27 x 10^6 by fishing and about 4 x 10^6 by natural deaths. Our estimates from the egg surveys are both obviously too low. The most probable cause of the underestimate is that we were not sampling over the entire spawning area.

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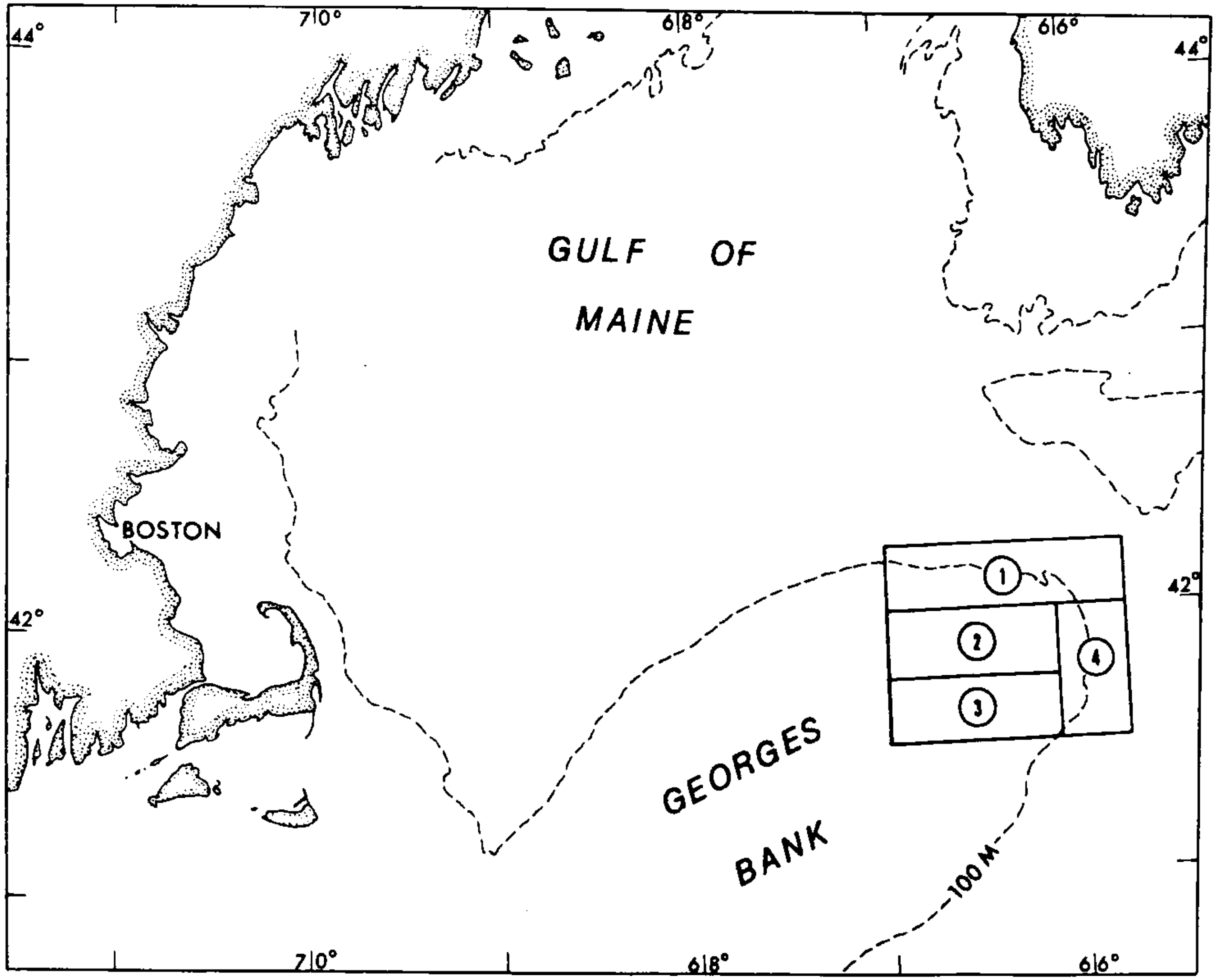

Fig. 1. The location of the sampling area in Subarea 5 showing the four strata.

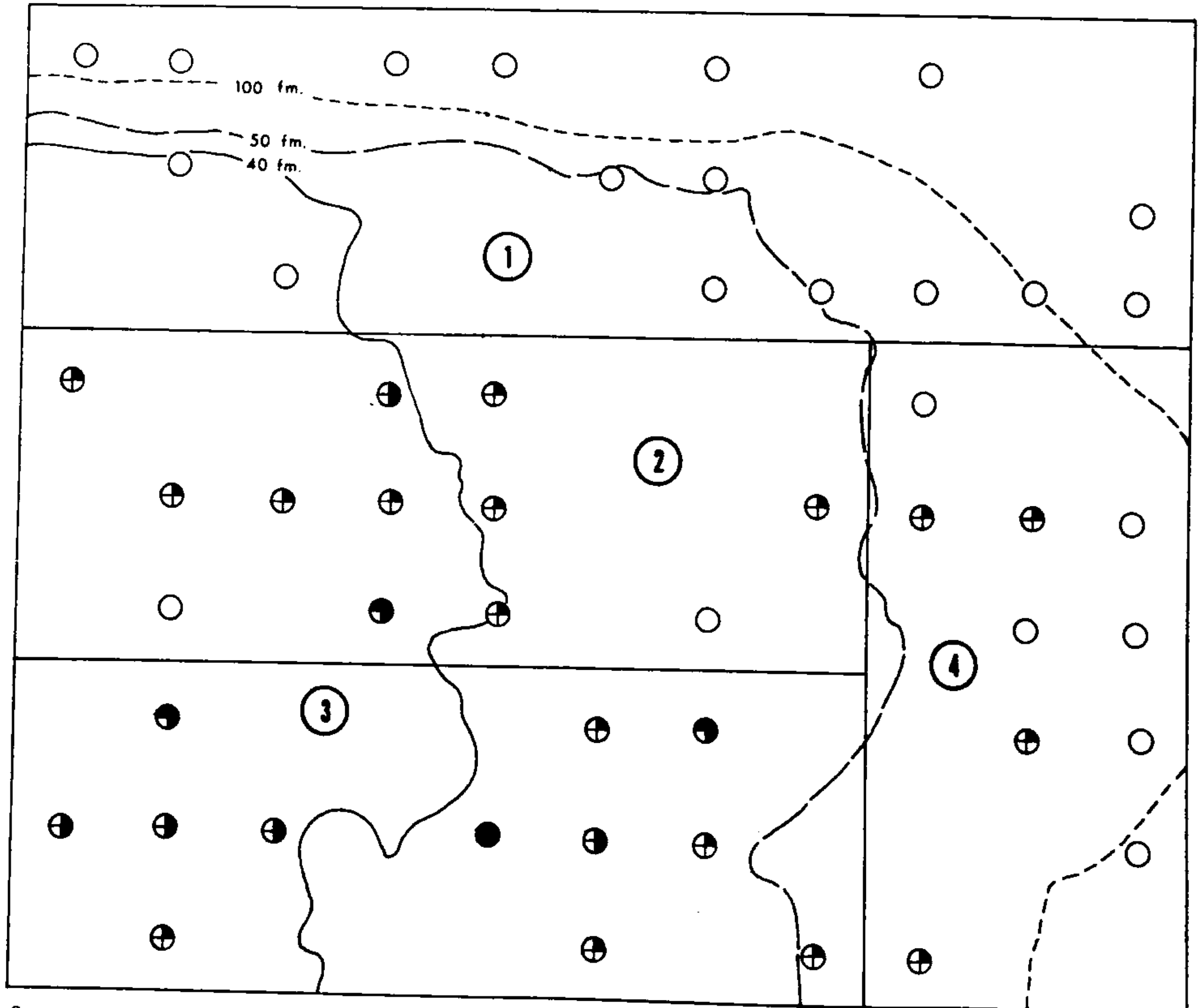

Fig. 2. Station pattern and results of the fourth cruise, 18 April. The symbols show the number of Stage I haddock eggs taken per cubic meter filtered. ○ = none, ⊕ =.001-.050 ◑ = .051-.100, ◕ = .101-.150, ● = .151=.200.

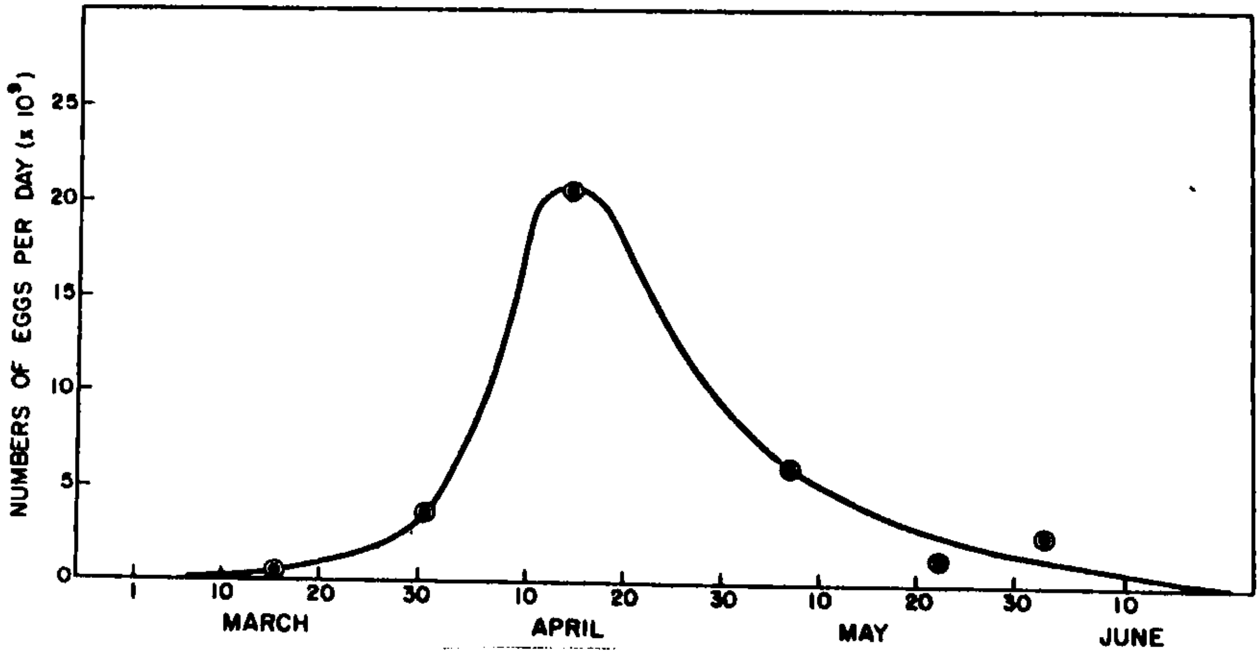

Fig. 3. Egg production curve for the sampled area using catches of Stage I eggs only.

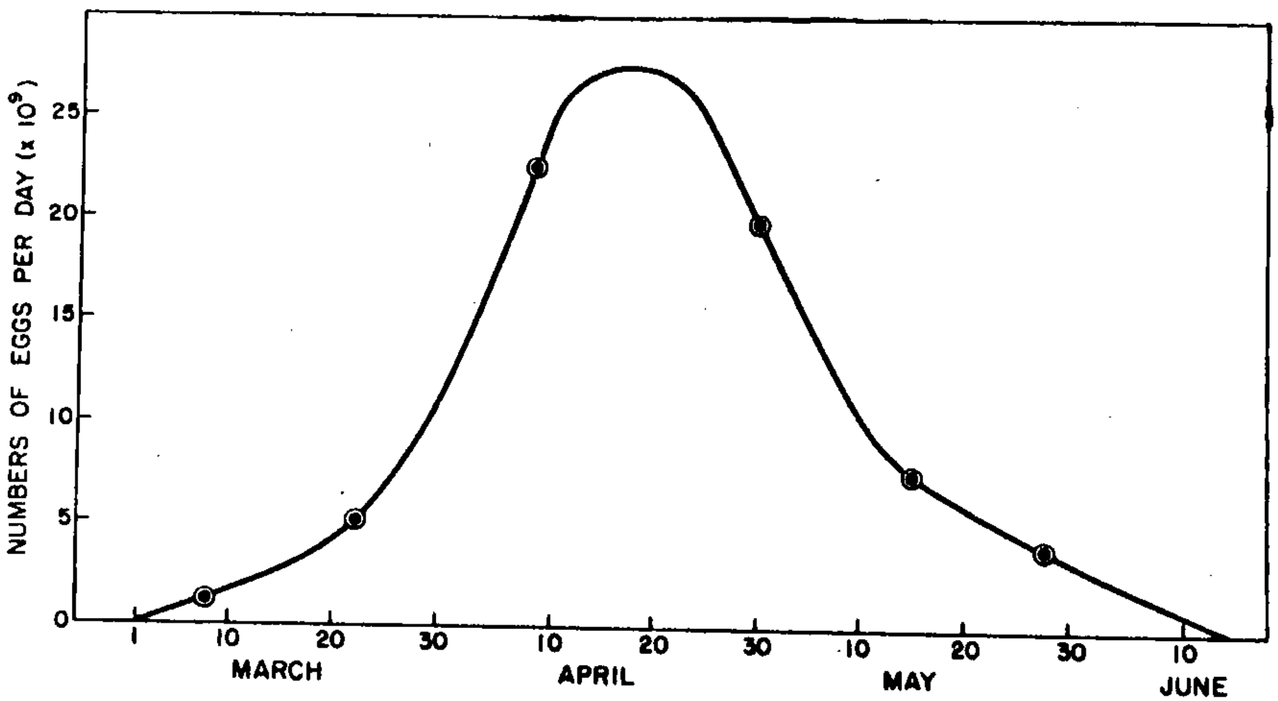

Fig. 4. Apparent egg production curve as a function of date. Data from all stages.

SECTION D
PLAICE

12. Trends in the American Plaice Fishery in ICNAF Subarea 3[1]

by T. K. Pitt
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Introduction

The main fishery for American plaice (*Hippoglossoides platessoides*) in ICNAF Subarea 3 occurs in Div. 3L and 3N. The fishery started in the late 1940's with the introduction of the otter trawler to the Canadian fleet. Generally speaking the fishery has remained primarily Canadian in this subarea, although since 1965 European trawlers principally those of the USSR and Poland have gradually increased their share of the landings so that by 1968 they were taking about 70% of the total from 3N (Fig. 1 and Table 1). Most of the Canadian landings were by Newfoundland trawlers and plaice has become the major species sought by the Newfoundland otter trawler fleet offshore.

Since 1954 sampling of commercial plaice has been carried out by the St. John's Biological Station. Most of the otoliths have been read and the age distributions, etc. are at present being processed. This document is a preliminary report of a more detailed assessment of the effects of increased exploitation on this species.

Materials and methods

The total landings especially for 3N (Fig. 1 and 4) are calculated values based on Newfoundland landings since the European fleet report the flounder in Subarea 3 merely as "unspecified flounder" in the ICNAF Statistical Bulletins. The amount of American plaice represented in this "unspecified flounder" total was calculated from the proportion that this species was of the total Newfoundland catch of plaice, yellowtail flounder (*Limanda ferruginea*) and witch (*Glyptocephalus cynoglossus*) from Div. 3L and 3N.

The standard unit of effort (Table 2) selected was the Newfoundland side trawler (151-500 tons) since up to 1964 practically all the landings were by this gear. To convert the effort of Newfoundland stern trawlers, which have gradually dominated the fishery since then, to standard side trawler units, a conversion factor of 1.2 was used. This was obtained by plotting the landings per hour of Newfoundland stern trawler against those of the side trawler by month and for the same statistical unit areas (as used by the St. John's Biological Station) (Fig. 2).

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[1] submitted to the 1970 Annual Meeting of ICNAF as ICNAF Res. Doc.70/27

Table 1. American plaice landings from ICNAF Div. 3L and 3N, 1954-68, in metric tons. (Canada (N) landings for 3L include inshore data.)

Year	Catch							
	Division 3L				Division 3N			
	Canada (N)	Canada (M)	Canada (Total)	Total all countries	Canada (N)	Canada (M)	Canada (Total)	Total all countries
1954	1,104	2,002	3,106	3,231	1,480	1,004	2,484	2,484
1955	5,315	6,178	11,493	11,493	1,054	1,134	2,188	2,188
1956	4,969	4,136	9,105	9,105	2,351	804	3,155	3,155
1957	3,933	4,514	8,447	8,447	2,530	662	3,192	3,192
1958	5,667	7,050	12,717	12,717	3,617	923	4,540	4,540
1959	7,584	5,044	12,628	12,628	4,104	393	4,497	4,497
1960	11,307	6,036	17,344	19,347	2,967	310	3,277	3,992
1961	8,200	3,143	11,343	12,431	2,967	63	3,030	3,644
1962	8,741	2,426	11,167	12,541	3,600	30	3,630	3,918
1963	13,028	2,874	15,902	16,488	6,859	593	7,452	7,452
1964	14,180	5,089	19,269	20,964	10,510	3,961	14,471	14,471
1965	14,446	4,275	18,721	24,533	21,105	4,094	25,199	26,071
1966	12,582	4,281	16,863	18,835	23,904	6,062	29,966	39,330
1967	29,247	5,200	34,447	38,344	13,948	2,193	16,141	32,452
1968	32,654	4,833	37,487	37,691	8,479	931	9,410	32,589

Table 2. Effort expressed in standard Newfoundland side trawler units. ICNAF Div. 3L and 3N, 1956-68.

Year	Effort (hours)			
	Division 3L		Division 3N	
	Canada (N)	Total all countries*	Canada (N)	Total all countries*
1956	5,749	10,535	3,000	4,715
1957	5,043	10,819	3,881	4,908
1958	5,409	12,870	5,301	10,616
1959	8,149	13,114	6,840	7,603
1960	8,363	22,477	4,793	10,283
1961	10,166	15,927	5,945	6,645
1962	12,634	16,407	6,857	9,495
1963	17,212	24,458	11,928	11,961
1964	19,175	32,117	13,543	18,690
1965	19,139	34,642	30,765	38,095
1966	18,591	27,820	35,784	53,956
1967	46,695	59,666	21,992	58,922
1968	62,430	67,766	16,991	73,955

* Calculated (see text)

Since very little data on landings and effort of flatfish by European trawlers were available to make direct comparisons with Newfoundland trawlers, it was necessary to make certain assumptions. Soviet trawlers, 151-500 tons, were considered to be equal to Newfoundland side trawlers with respect to catch per unit effort. Similarly, European 501-900 tonnage class trawlers were treated the same as Newfoundland stern trawlers of the same tonnage. The landings per hour by these latter trawlers were also used to calculate the effort of European factory ships (>1800) tons and the resulting effort is thus probably underestimated. These factory ships apparently caught 50% of the total "flounder" landed by European vessels. However, since a fair amount of redfish was included in their landings they probably fished at least part time beyond the usual plaice depth range (approximately 70-230 m). Some of the reported flounder may therefore have included fair quantities of witch, a species that normally inhabits deeper water than plaice.

Results

The landings of American plaice remained relatively static at about 12,000 tons from 3L and less than 5,000 tons from 3N until the early 1960's (Fig. 1). However, with the decline in the haddock fishery the Newfoundland fleet diverted its main effort to American plaice.

Div. 3L. The fishery here is almost exclusively Canadian (Fig. 1A, and Table 1) with the Newfoundland fleet taking a large percentage of the total landings. The landings per hour by Newfoundland trawlers have fluctuated somewhat (Fig. 3) with the overall trend being downwards. A plot of total landings against total effort seems to indicate that up to 1967 the landings were nearly proportional to the total effort (Fig. 4A). However, the levelling off from 1967 possibly indicates that the fishery has reached a point of maximum efficiency. The 1969 data are from Newfoundland only, but these probably represents 90% of the effort and landings for this area.

Div. 3N. Up to 1965 practically all the landings of plaice were by Canadian trawlers and here again the Newfoundland-based vessels landed the greatest proportion (Fig. 1B and Table 1). From 1966, however, Canadian landings have declined and European countries are taking most of the landings from this division. The landings per hour by Newfoundland trawlers have fluctuated, but from 1956 to 1961 there was a general downward trend (Fig. 3). However, for the next 3 years (up to 1964) landings per hour increased. This possibly reflects an increase in abundance of this species on the southern half of the Grand Bank coupled with a decline in haddock abundance. An increase in the abundance of a closely related species, the yellowtail flounder (*Limanda ferruginea*), in this locality (3N) has been fairly well documented (unpublished data, Fisheries Research Board of Canada, Biological Station, St. John's) and a similar condition could have occurred with American plaice. With the big increase in effort which occurred from 1964 onwards (Fig. 4B) the landings per hour have declined sharply especially since 1966 (Fig. 3B and 4B). As in 3L it appears that the point of peak efficiency for this fishery has been reached and from rough calculations of yield curves it is perhaps just beyond the maximum sustainable yield.

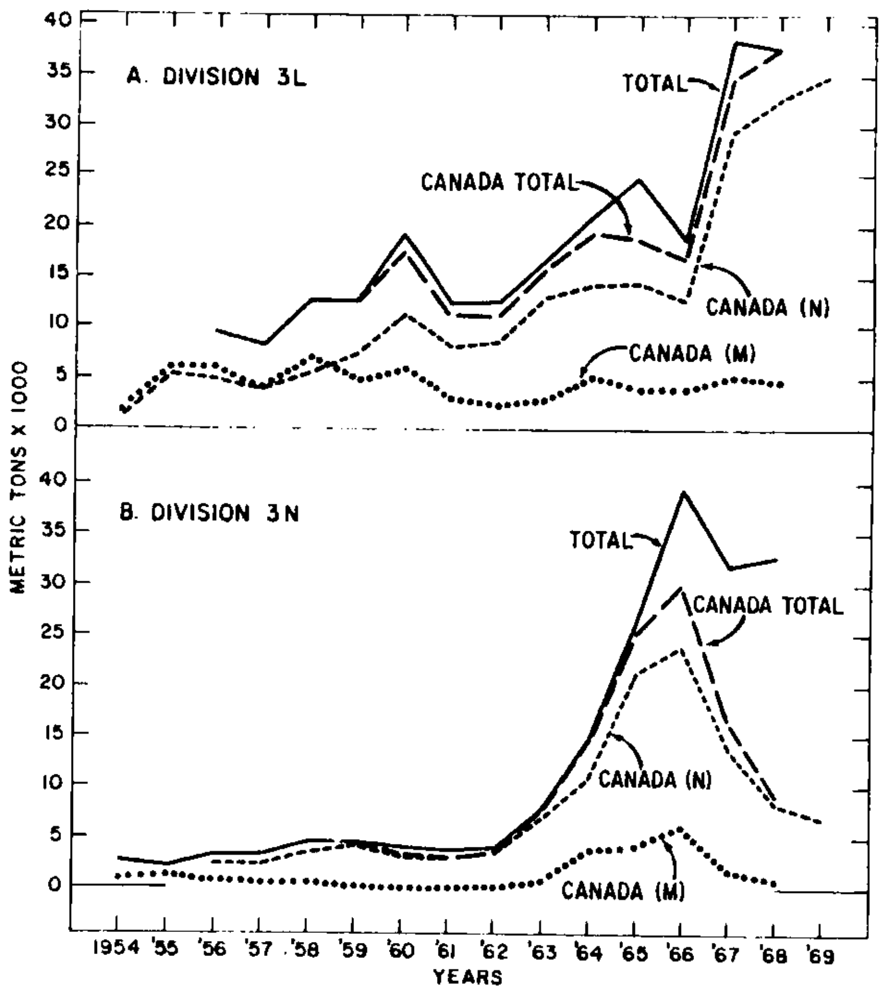

Fig. 1. A. Landings of American plaice from ICNAF Div. 3L.
B. Landings of American plaice from ICNAF Div. 3N

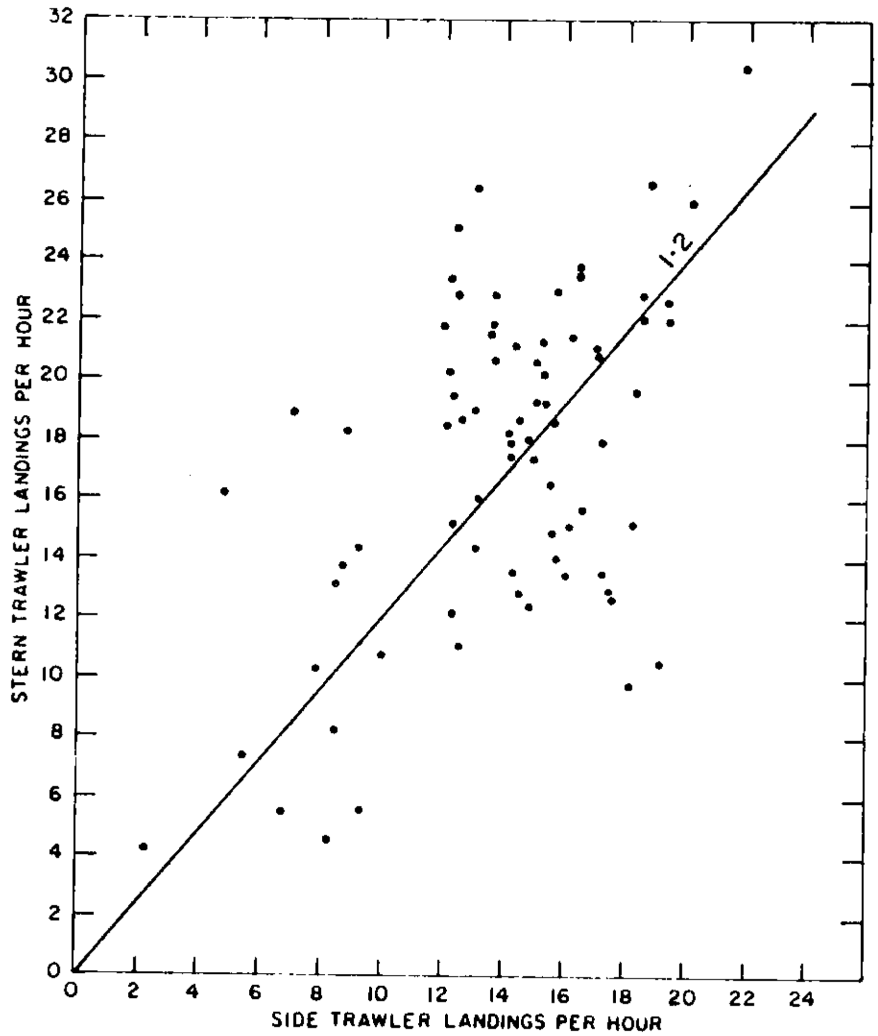

Fig. 2. Plaice landings per hour (averaged on a monthly basis for arbitrary statistical unit areas) for Newfoundland stern trawlers plotted against Newfoundland side trawlers.

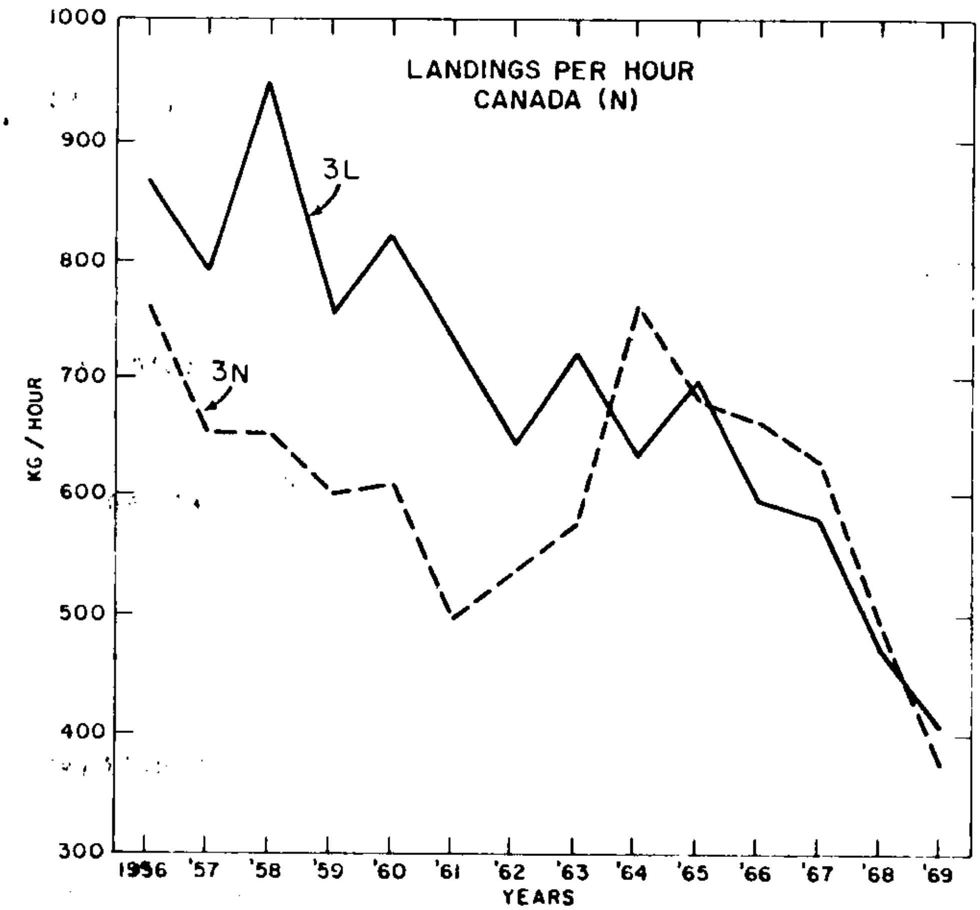

Fig. 3. Plaice landings per hour's trawling of Newfoundland trawlers in standard Newfoundland side trawler units.

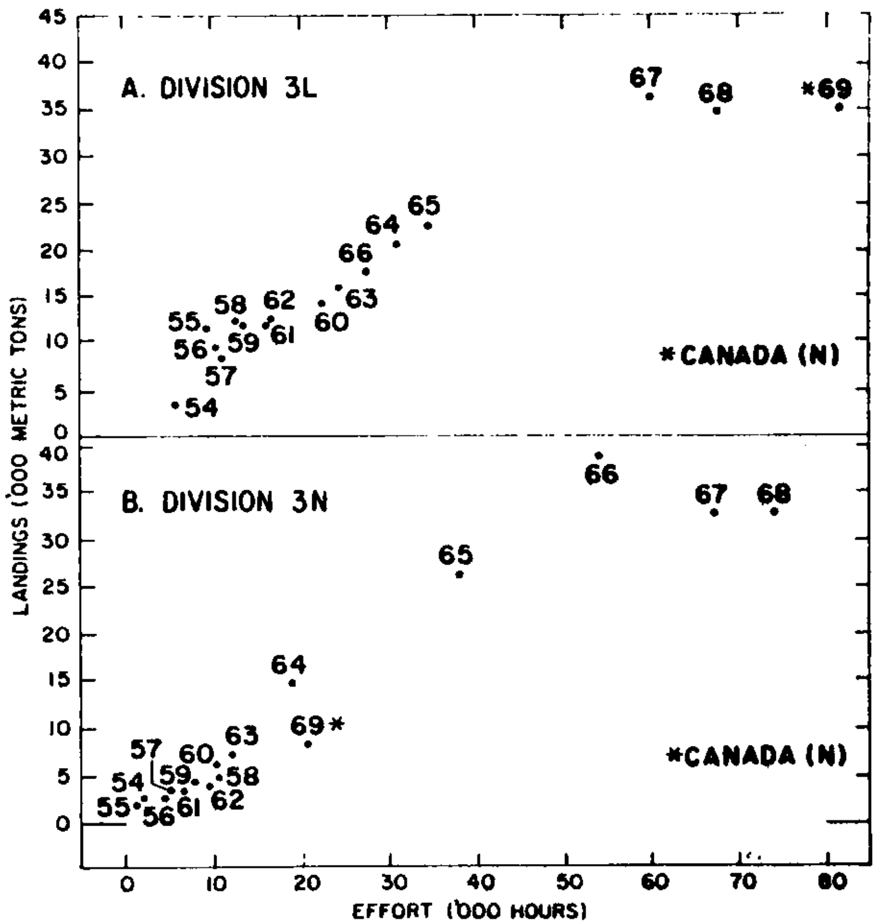

Fig. 4. Total landings of American plaice plotted against total effort for (A) Div. 3L and (B) Div. 3N.

SECTION E
YELLOWTAIL

13. The effects of large meshes in the yellowtail flounder fishery[1]

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Selection Experiments

Selection studies were carried out aboard two New Bedford yellowtail draggers in September 1967. The procedure followed was to use a codend of the mesh size to be tested on one vessel and a lined codend, which retained all sizes of yellowtail caught, on the other vessel. The vessels then made several pair tows with each combination on grounds southwest of Nantucket Shoals lightship. Bureau of Commercial Fisheries and Massachusetts Division of Marine Fisheries personnel on the vessels measured samples of the catches and obtained information on catch per tow of market and discard yellowtail. By comparing the catches of the lined and unlined codends, the selection curves of the tested codends were estimated.

The size of yellowtail in the area fished was small; most of them were under 15 inches long. We, therefore, obtained rather poor information on escapement of large fish. The cull mid-point for yellowtail by the commercial fleet was about 13.5 inches (34 cm) in September. That is, yellowtail under 13.5 inches were mostly discarded.

Selection information was obtained for 2 codend mesh sizes: 5.1 inches (129 mm) and 5.7 inches (145 mm). The 5.1 inch mesh was made of twisted nylon and the 5.7 inch was made of braided nylon.

The yellowtail catch data for the 5.1 inch codend versus the lined codend, based on 6 pair tows, are given in the table below.

Table 1. 5.1 inch codend and lined codend compared

Yellowtail Size Category	Catch-bushels per hour 5.1 inch codend	Catch-bushels per hour Lined codend
Market >34 cm	3.9	2.5
Discard	4.5	6.8
Total	8.4	9.3

This codend caught relatively more market yellowtail (3.9 bushels/hour) than the lined codend (2.5 bushels/hour), while releasing some of the undersized fish.

[1] submitted to the 1970 Annual Meeting of ICNAF as Res. Doc. 70/86.

The selection curve for the 5.1 inch codend is shown in Fig. 1. From this curve it is estimated that 75% of the 9.9 inch (25 cm), 50% of the 11.4 inch (29 cm - age 2.5 years), and 25% of the 12.6 inch (32 cm) yellowtail were released by this codend. It retained most of the market fish (those 13.5 inches and over).

The yellowtail data for the 5.7 inch codend versus the lined codend, based on 3 pair tows, are given in the table below. The 5.7 inch codend caught 3.6 bushels per hour of the market sized fish as compared to 7.6 bushels per hour with the lined codend.

Table 2. 5.7 inch codend and lined codend compared.

Yellowtail Size Category	Catch-bushels per hour 5.7 inch codend	Catch-bushels per hour Lined codend
Market	3.6	7.6
Discard	6.5	16.7
Total	10.1	24.3

The selection curve for the 5.7 inch codend is shown in Fig. 1. This curve indicates that 75% of the 10.9 inch (27.7 cm), 50% of the 13.5 inch (34.3 cm - age 3.1 years), and 25% of the 15 inch (38.1 cm) fish escaped through the meshes. A large amount of market yellowtail were released by this codend.

Effects of increase in mesh size on catch and landings

It is important that the assessment be made using total catch of fish, i.e. both the discards (at sea) and landings. In order to average out variations in recruitment from year to year, we have used the average of discards and landings for the years 1963-1966, inclusive. (Fig. 2 (top panel)). Discards usually were greatest in the 3rd and 4th quarter. The annual discard averaged about 11,000 metric tons, compared with landings of 33,000 metric tons.

The catch and landings given here are for the food fish fishery only, which includes over 90% of the catches. The vessels use a 4.5 inch (114 mm) mesh codend. Applying the selection curves of the 5.1- and 5.7 inch codends relative to a 4.5 inch codend to the catch composition of the 4.5 inch mesh, and assuming that the discarding practices would remain the same, the estimated catches and discards with the new meshes are obtained (Fig. 2). These estimates are for the period immediately following a change to the bigger mesh.

Discards are reduced by 27% and 56%, and the immediate landings by 4% and 21%, for the 5.1 inch and 5.7 inch mesh codends, respectively, relative to that with the 4.5 inch mesh. The 5.7 inch mesh reduces the immediate landings by nearly half as much as the discards.

In the long run, there would be a gain with the 5.1 inch mesh of 10% in landings, relative to those of the 4.5 inch mesh; with the 5.7 inch mesh there would be a long term gain of 17% in landings.

The immediate and long term effects of changing to the larger mesh sizes are summarized in Table 3. The immediate loss to landings of 4% with the 5.1 inch mesh would probably be made up within a year, or at most 18 months. The full gain of 10% would be achieved in about 4 years. The immediate loss of 21% with the 5.7 inch mesh would be made up in 24-30 months.

Although the data on selectivity is not as complete as we should like, we do not believe that further experiments would radically change the present conclusions. A significant change might be obtained if the selectivity could be sharpened, so that all the fish under 30-31 cm, which are now almost entirely discarded, would be released and fish over 32 cm would be retained in larger proportions. This might double the gain, without increasing immediate losses to landings. However, even with sharp selection, moving the 5% retention point beyond 33 cm would remove too many larger sized fish, and an increase in growth of yellowtail at these lengths would provide little in the way of long term gains.

The amount of fishing effort on yellowtail is also important to the assessment. We have estimated the fishing rate to be 80%, which is relatively high. This means that once the fish are vulnerable to the gear, 80% of a given year-class will eventually be caught. Again, this figure is not precise; if it were less, the benefits of mesh change would be less than indicated; the converse would hold if the fishing rate was greater.

Table 3. Immediate and long-term effects of increasing mesh size from 4.5 inch to 5.1 inch and 5.7 inch.

New mesh	% change in landings Immediate	% change in landings Long term (4 yrs)	% change in discards
5.1 inch	- 4	+10	-27
5.7 inch	-21	+17	-56

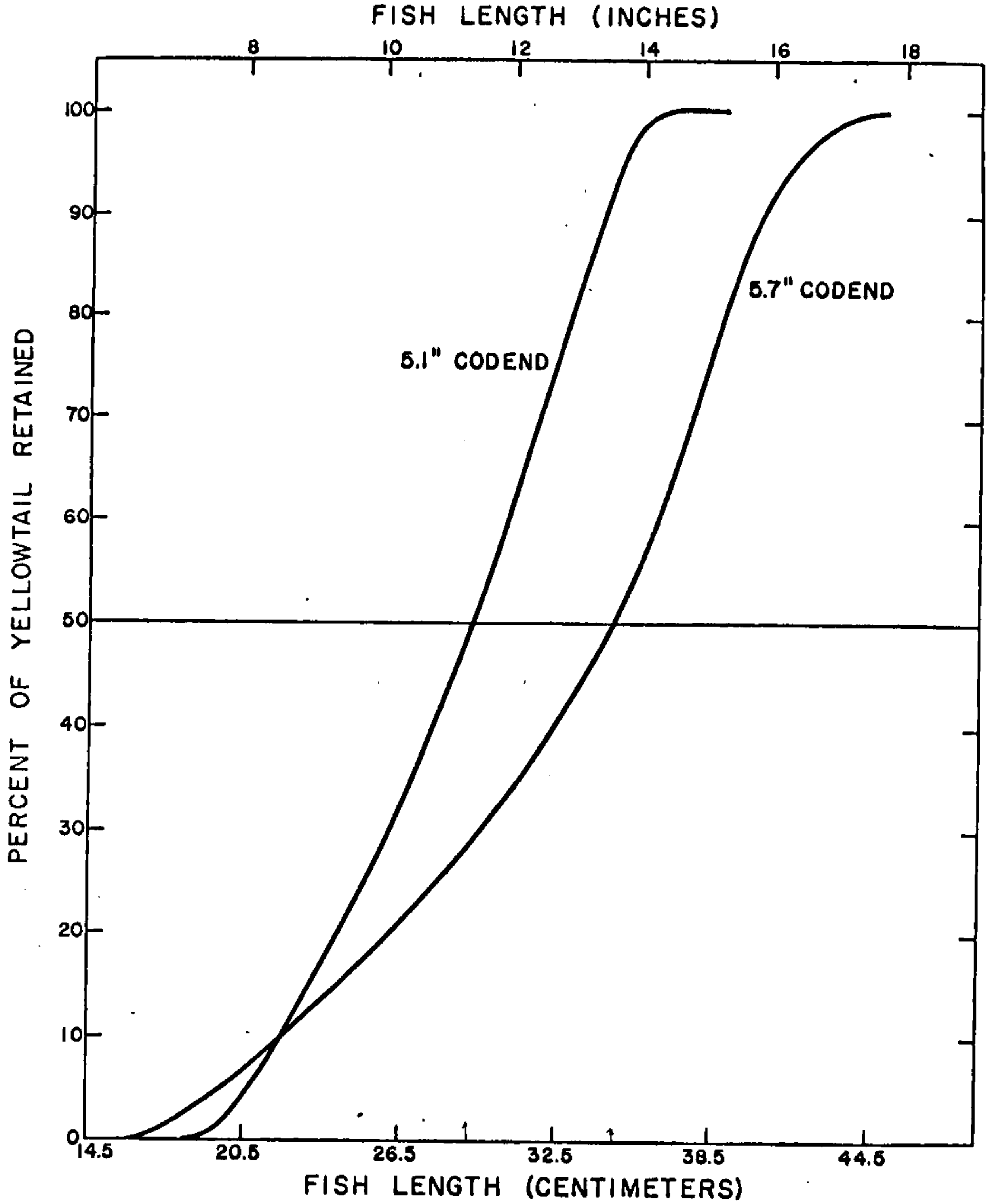

Fig. 1. Selection curves for 5.1 inch and 5.7 inch codends.

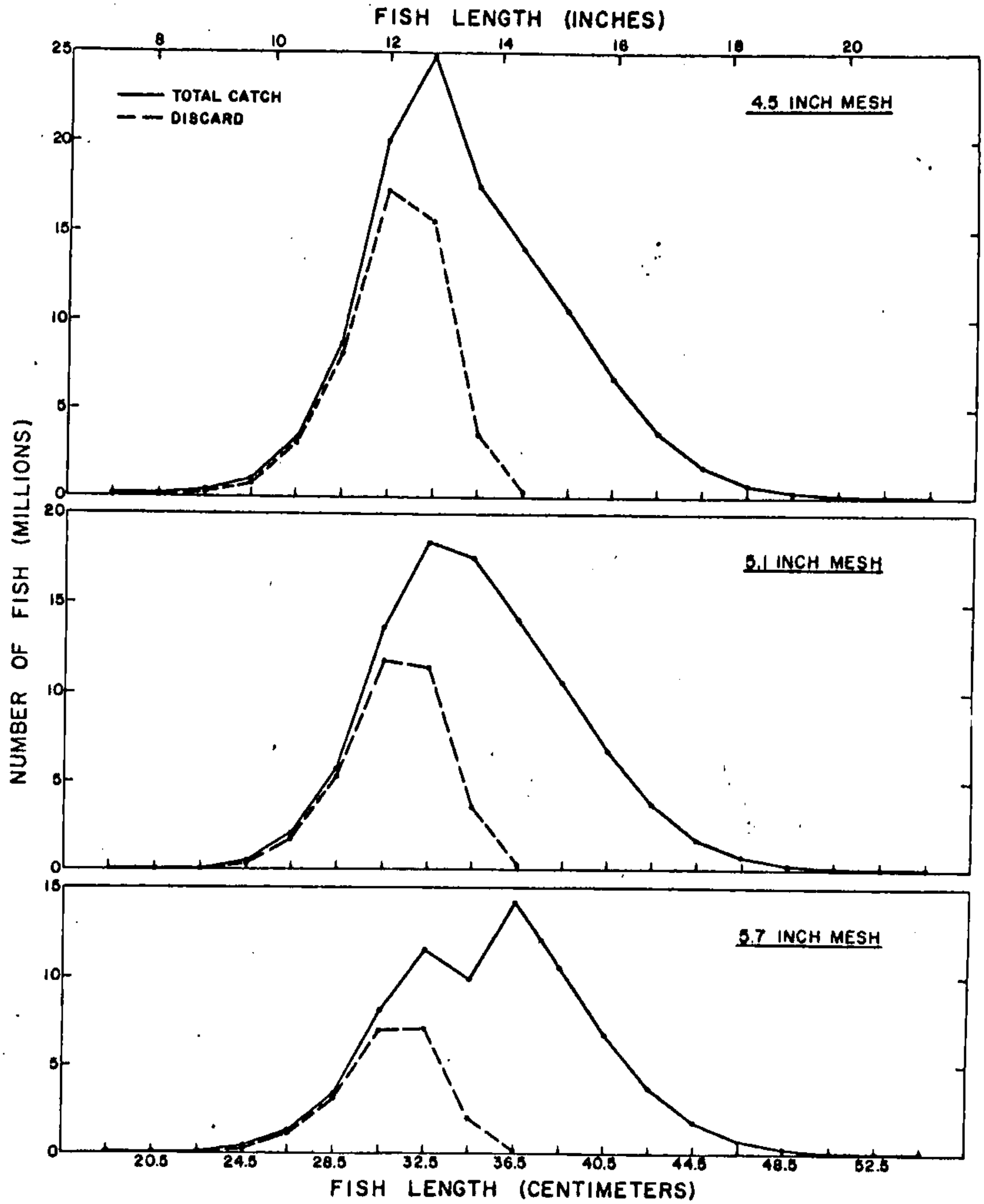

Fig. 2. Estimated length compositions of total catch and discards of yellowtail with 3 different codend mesh sizes. (Length compositions are based on the composition in 1963-66.)

SECTION F
HERRING

14. The Fecundity of Georges Bank Herring[1]

by B. Draganik and B. Rast
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This report presents the results of investigations on the fecundity of herring, which spawn in September-October on Georges Bank. It adds further observation to the studies by Yudenov (1966) and Perkins and Anthony (1969). The problem dealt with may be of great importance for the determination of the relation between spawning potential and the recruitment from a given stock.

Material and method

The sampling for this report was made in August 1968 in the central part of Georges Bank. The fish were taken from bottom-trawl catches. The length distribution of female herring in the samples was similar to the length distribution of fish in the catches. Length and age of all fish in the samples were determined. During the sampling period the female gonads were in the stage of maturity IV-V. The ovaries after being removed and marked were kept frozen. In the laboratory they were defrosted and placed in Gilson's fluid. A few weeks later they were chopped into small bits. The eggs were separated from ovarian tissue and washed several times, then dried on filter paper at room temperature. Each dry sample, taken at random, was weighed and the number of eggs in it was determined. Having the number of eggs per unit weight it was possible to establish the number of eggs in the whole ovary. In this way the fecundity of 167 herring specimens was determined. The length of these fish ranged from 26.0 to 35.5 cm and the age between 3 and 11 years. Detailed data is given in Table 1.

Table 1. Length and age of herring taken in August 1968 for fecundity studies.

Year-	Length in half centimetres																			
Class	26		27		28		29		30		31		32		33		34		35		Total
1965	1	–	–	–	1																2
1964			2	–	3	2	3														10
1963					2	3	5	6	4	3	3	1									27
1962					1	–	–	–	–	2	8	3									14
1961									2	–	7	3	6	6	3						27
1960											1	3	15	21	10	6	2				58
1959														5	5	–	1	3			14
1958																	1	3	–	1	5
1957																		2			2
Age not determined								1	–	–	–	–	1	1	–	2	1	1	–	1	8
Total	1	–	2	–	7	5	8	7	6	5	19	10	22	33	18	8	5	9	–	2	167

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[1] submitted to the 1970 Annual Meeting of ICNAF as Res. Doc. 70/63.

Results

The fecundity of each of the examined females was determined on the basis of three samples. The differences between the extreme values for the number of eggs, established in this way, did not exceed 5%. The individual fecundity varied between 21,000 and 166,000 eggs. The fecundity of each fish was related to its length and age. The increase of gonad size in August caused rapid changes in the weight of individual fish during sampling and, therefore, the relationship between the weight and the fecundity at that period was not reliable.

The data on the relation between length of fish and the number of eggs are given in Fig. 1. It shows considerable variation in the number of eggs in fish of the same size. The standard deviation from the mean number of eggs in fish, divided into 1 cm length-groups, ranges from 20,000 to 29,000.

For the equation

$$F = nL^a \quad \text{(Baxter, 1959)}$$

where

F - the fecundity
L - the length of herring
n and a - constants for a given population,

expressing the relationship between fecundity and fish length, the following parameters have been found for Georges Bank herring: n = 5.76 and a = 0.0001749. These were derived from the results of investigations and calculated by the method of least squares.

It is more convenient, however, to use for calculations the logarithmic equation:

$$\log F = 4.2426 + 5.76 \log L$$

The mean fecundity of herring determined on the basis of this equation for the length-classes from 26 to 35.5 cm is given in Table 2.

These results are lower than analogical ones obtained by Perkins and Anthony (1969). On the other hand the data obtained by these authors are in turn by similar magnitude lower than the results obtained by Yudanov (1966). The mean indices obtained for the fecundity of Georges Bank herring are slightly higher than analogical ones obtained by Sosinski (1970) for herring from the Norwegian Channel, spawning in the winter-spring period.

Table 2. Mean number of eggs in the ovaries.

Length of herring (cm)	Mean number of eggs
26.0	24,700
26.5	27,000
27.0	30,700
27.5	33,500
28.0	37,900
28.5	41,900
29.0	46,600
29.5	51,100
30.0	56,300
30.5	62,000
31.0	62,100
31.5	74,600
32.0	81,600
32.5	89,400
33.0	97,600
33.5	106,300
34.0	115,900
34.5	126,000
35.0	137,000
35.5	148,000

The variation in the mean number of eggs in the ovaries related to age is given in Table 3. There is only one deviation from the distinct regularity of increase of mean fecundity along with age, namely the phenomenon observed in the 1960 year-class in which the fecundity was lower while it was higher in the younger 1961 year-class. The 1960 year-class was the most abundant in the sample. Introducing the division into classes of 5,000 eggs this age-group was distributed in each one as shown in Fig. 2.

Table 3. Mean number of eggs in herring of particular age-groups.

Age-group	III	IV	V	VI	VII	VIII	IX	X	XI
Mean number of eggs	26.3	42.2	58.5	69.7	96.7	90.4	97.7	98.5	109.3

This distribution shows all the features of a regular distribution with a large range of variations. Such distribution for other age-groups is less regular in view of a small number of fish.

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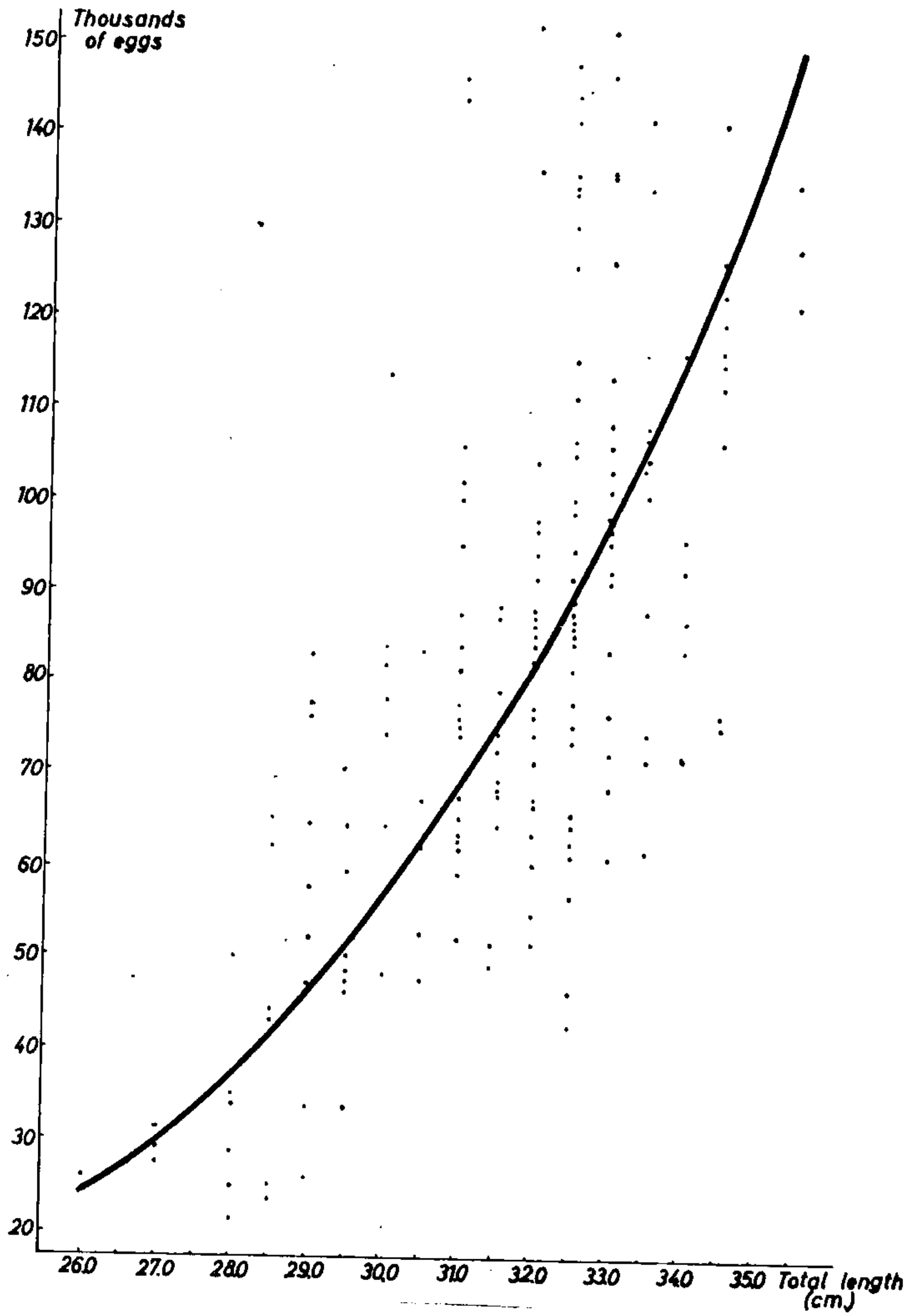

Fig. 1. The relationship between the number of eggs and the length of herring.

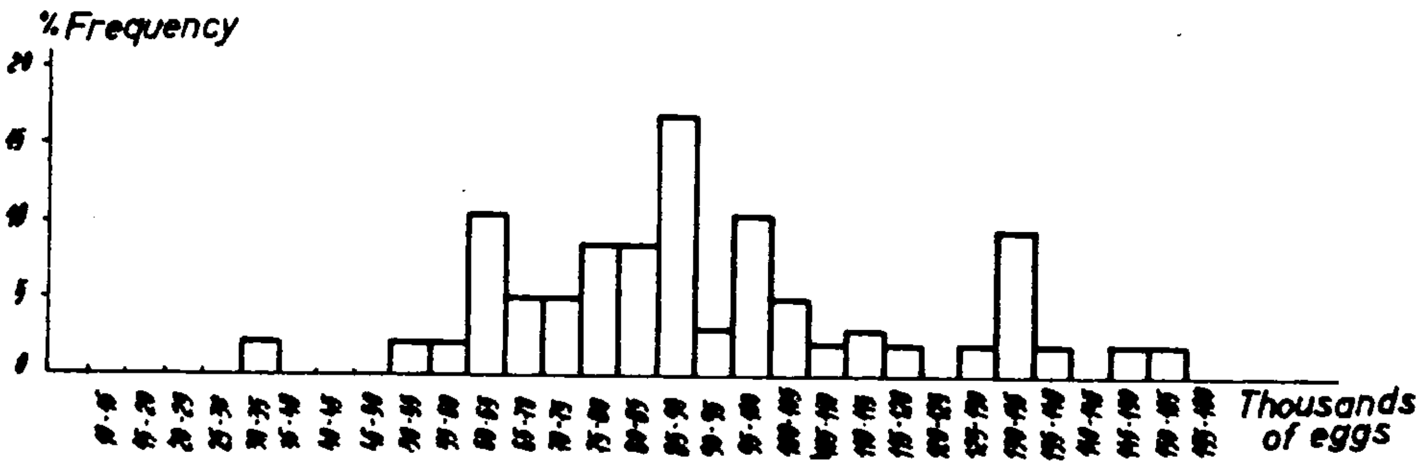

Fig. 2. The percentage of 8 year old herring with varying numbers of eggs.

15. Cooperative Herring Egg Survey - Georges Bank, 1969[1]

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Procedure

Biologists from AtlantNIRO, Kaliningrad, USSR, and the Bureau of Commercial Fisheries Laboratories, Boothbay Harbor, Maine and Woods Hole, Mass. participated in a cooperative research cruise 30 September - 4 October, 1969, on Georges Bank. The purpose of the joint effort was to evaluate the spawning success of Atlantic herring, *Clupea harengus harengus*, by defining areas of spawning and density of herring eggs on the spawning beds. Two USSR research vessels, the *Aliot* and *Ekliptika* and the *Albatross IV* from Woods Hole, Massachusetts conducted the research. Four Russian scientists participated in the research aboard the *Albatross IV* and 3 American scientists sailed aboard the *Ekliptika*. Five areas were investigated on Georges Bank (Fig. 1). The Russian vessel *Aliot*, which had been conducting egg surveys prior to the cooperative efforts of the USA and USSR had located eggs at the following 3 locations: 41°58'N, 67°15'W; 42°00'N, 67°30'W; and 41°38'N 68°20'W. Area 3 was chosen for the initial survey because of the heavy spawning in this area and the proximity of two other spawning areas. The *Ekliptika, Aliot,* and *Albatross IV* surveyed 7 x 10 nautical mile areas as indicated in Fig. 2, by dredging along the bottom for 15 minutes at each station. A Naturalist dredge was used by the *Albatross IV*. The *Aliot* used a non-standard rectangular dredge made on board the *Aliot*. Another Russian dredge with a triangular mouth opening, 1 m on each side was used by the *Ekliptika* in addition to the Naturalist dredge. The Russian triangular dredge seemed to operate more efficiently than the Naturalist dredge, although the variability in the amounts of catch was too great to allow a satisfactory assessment of the catchability of the two gears.

A buoy was set out by the *Albatross IV* at 41°59.5'N by 67°32.5'W over the centre of an egg patch. The *Aliot* also set out a buoy approximately 0.75 miles southwest from the US buoy (Fig. 3). A major difficulty associated with herring egg research is in locating the exact position of the egg patches. The US buoy as shown in Fig. 3 is the location determined by the *Aliot*. This is nearly 3 miles southeast of the location as determined by the *Albatross IV*. Grab sampling began around the buoys by the *Aliot* and *Albatross IV*, and samples of eggs were saved for counting purposes. Trawl tows to sample the spawning herring and predator populations were made each day at noon and midnight. Stomachs of all predators were saved for laboratory analysis. Bongo tows to sample drifting herring larvae were made to determine if hatching had begun or whether larvae had drifted in from nearby areas. If considerable drifting

[1] submitted to the 1970 Annual Meeting of ICNAF as Res. Doc. 70/70.

occurs, any study of larval dispersion away from a given egg patch would be difficult. Photographs were also taken of the sea bottom to determine egg variability and bottom conditions.

The *Ekliptika* moved to Area 4 (Fig. 1) on 2 October and began a dredge survey as shown in Fig. 4. Herring eggs had been found previously in this area by the *Aliot*. On 4 October, the *Ekliptika* moved to Area 5 and began a survey as previously done in the first two areas. Only seven stations were completed because of inclement weather.

Results

No eggs were found in the dredge surveys in Areas 1, 2 and 3 even though at least two egg patches were known to be present. The dredge stations located at 2 mile intervals were apparently too far apart for effective detection of egg patches. A better means of locating spawning sites is by sampling the adult spawning population and noting the presence of newly spawned herring.

The grab stations occupied by the *Aliot* on 28-29 September and 2-3 October, 1969 are shown in Fig. 3. The egg patch inside the US circle was found on 28-29 September. On 2 and 3 October the egg patch on the southwest border of the circle was surveyed. Both were found by the *Aliot*. The location and grams of eggs found per square meter of bottom by the *Aliot* on 2 and 3 October, 1969 are given in Table 1. The stations occupied by the *Albatross IV* on 2 and 3 October are also shown in Fig. 3. Samples of the eggs taken by the *Albatross IV*, usually one tenth of the entire sample, were returned to the Boothbay Harbor Laboratory and counted. The location of the samples, depth and egg amounts are given in Table 2.

The number of herring eggs laid on Georges Bank in a given year is given by the egg patch size and number of eggs laid per square meter of bottom. The extent of each egg patch was difficult to determine. In Fig. 3, eggs were found at 4 locations where egg patches were not thought to exist. Area 4 may also be a significant egg producing area. The outlined egg patches in Fig. 3 must provide a minimum estimate of spawning area. Apparently a great number of egg grabs are needed to detect the presence of the smaller egg patches. The counts of eggs per square meter of 20 stations varied from 1,970 to 6,821, 400 eggs per square meter with the greatest count being found on an isolated station at 41°58.2'N and 67°29.1'W. (Fig. 5). The mean number of eggs counted per station was 1,395,000 per square meter with a 95% confidence interval of ± 852,900 eggs per square meter. It is obvious that not only can many small egg patches be undetected but the size and shape of the patch and the mean number of eggs per square meter are sources of error. In the centre of both egg patches of Fig. 5 are found stations with very low egg counts indicating the great unevenness of the quantities of eggs. Another area sampled by the *Aliot* prior to the cooperative work is shown in Fig. 6. This egg patch is Area 2 in Fig. 1 and represents a new spawning location. Spawning in previous years had been found north of this area but not at this location (Fig. 7). The research by the USSR since 1964 indicates that the size of the spawning stock has been declining resulting in fewer and fewer eggs. Figure 7 shows the sizes of the egg patches in 1964-66 and in 1969. Spawning was scattered in 1969 producing smaller, diffuse patches of eggs suggesting that the spawning population was continuing to decline. Research should be continued to substantiate this conclusion.

Table 1. Egg grabs of *Aliot* around buoy located at 41°57.7'N, 67°29.9'W, October 2-3, 1969.

Station number	Latitude	Longitude	Grams of eggs per square meter	Eggs per square meter
2	41°57.7'N	67°30.5'W	5,800	2,644,800
5	41°59.2'N	67°30.5'W	1,010	460,560
9	41°57.6'N	67°29.8'W	440	200,640
14	41°58.7'N	67°29.1'W	460	209,760
36	41°57.6'N	67°30.0'W	370	168,720
39	41°57.9'N	67°30.0'W	1,200	547,200
40	41°58.0'N	67°30.2'W	6,350	2,748,915
41	41°57.7'N	67°29.4'W	3,890	1,773,840
43	41°58.3'N	67°30.2'W	-----	-----
45	41°57.8'N	67°30.2'W	7,000	2,749,600
61	41°58.2'N	67°29.1'W	14,030	6,821,386
90	41°57.8'N	67°31.8'W	-----	1,967
91	41°57.7'N	67°29.9'W	-----	2,644
92	41°57.8'N	67°29.8'W	9,350	4,802,160

No counts were made of the layers of eggs making up the egg patch and no estimates of differential mortality were made by egg layers because the quantity of eggs laid was so small in 1969. If the egg mass had been reasonably thick as reported in past years, samples would have been taken from both the top and bottom layers to assess mortality differences between the eggs laid first and those laid last. By placing the eggs in 3% formalin the dead, opaque eggs are readily visible. The number and age of the layers and the ages of the adults spawning each layer are very important in assessing egg mortality and stock-recruitment.

Most of the eggs caught in the grabs were mixed with sand and gravel so no thickness of the egg mass could be measured. Table 3 gives the limited data obtained on thickness from the grabs of the *Albatross IV*.

Bongo tows for larvae were made by the *Albatross IV* around the buoy. Table 4 gives the number and size of larvae caught. The 20 mm larva found in tow number 4 indicates that larvae found over an egg patch may be from a neighbouring spawning area. Photographs were made of the ocean bottom around the buoy to further determine the variability of eggs in the egg patch. As the camera was lowered to the bottom a picture was taken as the camera supports struck bottom. The clarity of the photographs was poor and the equipment needs to be improved for further work.

Table 2. Egg grabs of *Albatross IV* around buoy located at 41°59.5'N, 67°32.5'W, 2-3 October, 1969.

Grab No.	Direction	Distance from buoy	Depth (fm)	Egg Amounts	Size of sample(ml)	Eggs per square meter
1	348°	75 yards	22	1070 ml(21,299 eggs)	105	2,129,900
2	128°	200 "	22	0	—	—
3	235°	200 "	22.5	Trace	—	—
4	240°	.50 mile	22.5	"	—	—
5	270°	25 yards	22.5	fair amount	—	—
6	55°	75 "	22.5	470 ml(28,933 eggs)	120	1,133,219
7	155°	300 "	22	0	—	—
8	125°	75 "	22.5	4 ml(507 eggs)	4	5,070
9	60°	80 "	22.5	0	—	—
10	35°	80 "	22	270 ml(2,587 eggs)	27	258,700
11	340°	.50 mile	22	0	—	—
12	320°	.25 "	22.5	0	—	—
13	0°	.25 "	22.5	0	—	—
14	295°	.25 "	22.5	180 ml(7,193 eggs)	18	719,300
15	215°	.13 "	22.5	Trace	—	—
16	180°	50 yards	22.5	Trace	—	—
17	210°	100 "	22.5	0	—	—
18	180°	.25 mile	22.5	0	—	—
19	140°	.30 "	22.5	0	—	—
20	320°	.25 "	22.5	120 ml(3,193 eggs)	12	319,300
21	85°	100 yards	22	60 ml(9,988 eggs)	20	199,760
22	220°	200 "	22	0	—	—
23	40°	.75 mile	22.5	0	—	—
24	10°	.25 "	22	0	—	—
25	170°	150 yards	22	0	—	—
26	200°	200 "	22.5	0	—	—
27	270°	50 "	22	0	—	—
28	345°	100 "	23	0	—	—
29	320°	.25 mile	22	Trace	—	—
30	10°	75 yards	22.5	0	—	—
31	30°	.25 mile	22	0	—	—
32	70°	200 yards	22	Trace	—	—
33	45°	250 "	22	0	—	—
34	10°	.25 mile	22	0	—	—
35	320°	.25 mile	22	0	—	—
36	350°	.25 "	22	0	—	—

Table 3. The average thickness of the egg mass as measured by the *Albatross IV*.

Grab No.	Average thickness (mm)
1	22
5	1 egg layer (1 mm)
6	1 egg layer (1 mm)
14	5
20	2 or 3 egg layers (2-3 mm)
21	2 or 3 egg layers (2-3 mm)

Table 4. Results of Bongo tows (15 minutes)of *Albatross IV* on Cruise 69-10 (3-4 October, 1969).

Tow No.	Tow Location	Number of larvae	Mean total length(mm)	Range in length(mm)
1	41°-59.5'N 67°-32.5'W	21	9.7	5.0-16.5
2	41°-59.5'N 67°-32.5'W	11	5.2	5.0-6.0
3	41°-57.5'N)_(41°-56.6'N 67°-51'W)¯(67°-52.5'W	0	---	---
4	41°-45.8'N 68°-12.4'W	1	20.0	---
5	41°32'N)_(41°31'N 68°34.5'W)¯(68°35.5'W	2	9.0	8.5-9.5
6	41°14'N)_(41°12.5'N 68°50'W)¯(68°51'W	0	---	---
7	40°55.5'N)_(40°57.2'N 69°05.5'W)¯(69°05.5'W	0	---	---

Progress was made in the cooperative work in 1969 toward determining the variability associated with estimating the number of eggs in a given egg patch and the problems of dredge sampling. The cooperative egg research conducted in 1969 was the first such cooperative herring research and it is intended that this cooperative research will continue.

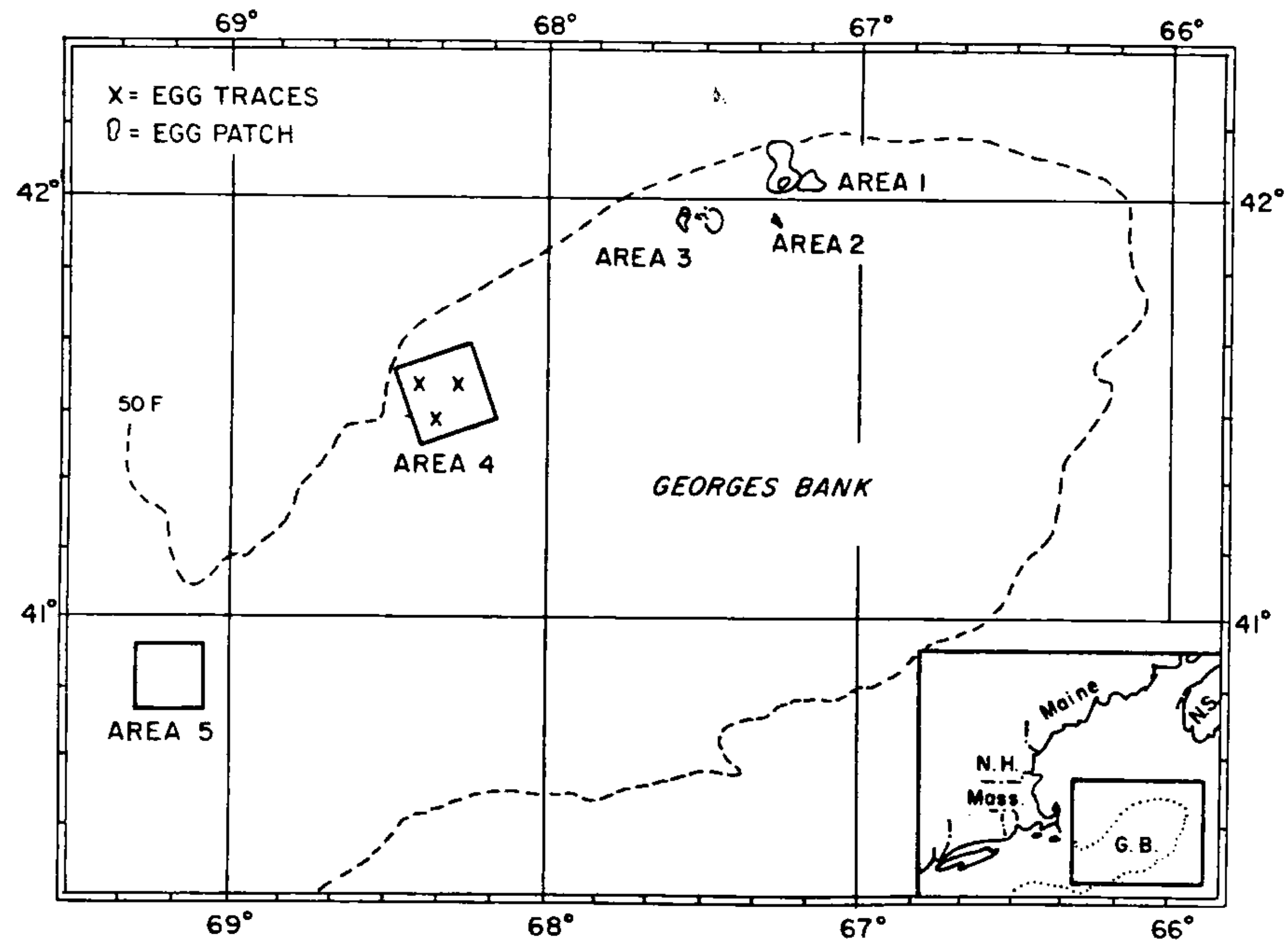

Fig. 1. The areas of investigation during the 1969 cooperative egg research on Georges Bank by the USSR and the US.

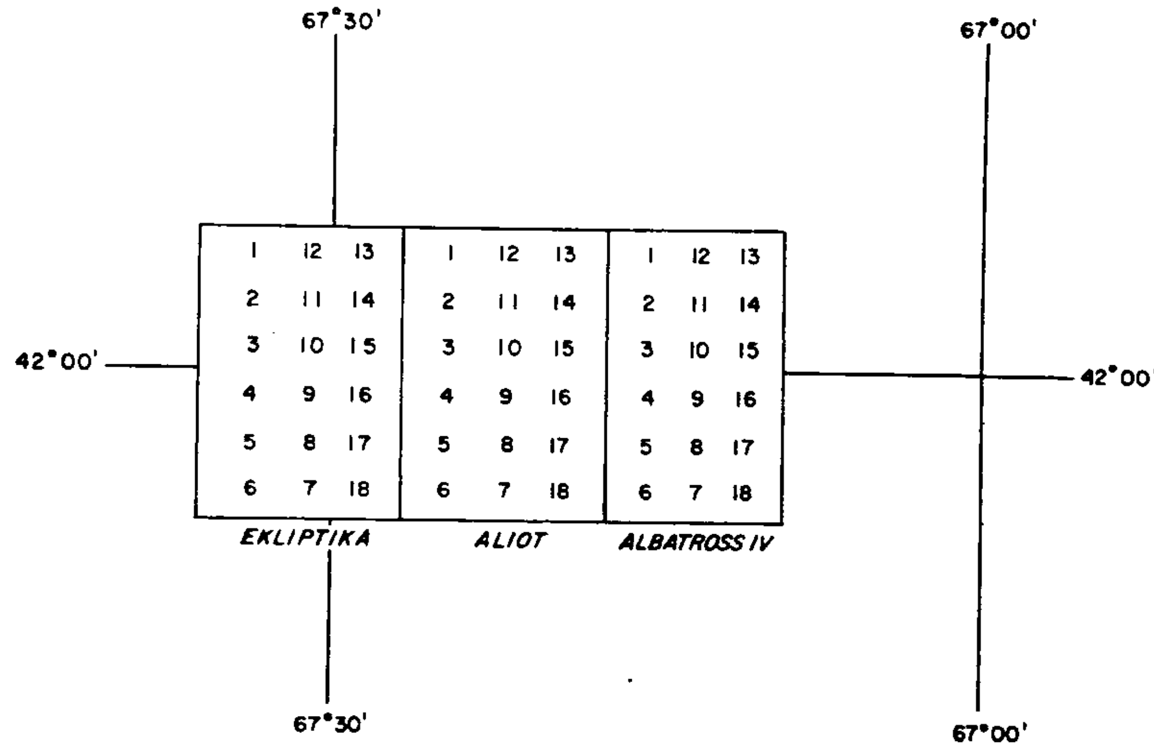

Fig. 2. The stations of the herring egg survey by the *Ekliptika*, *Aliot*, and the *Albatross IV* on 1 October, 1969.

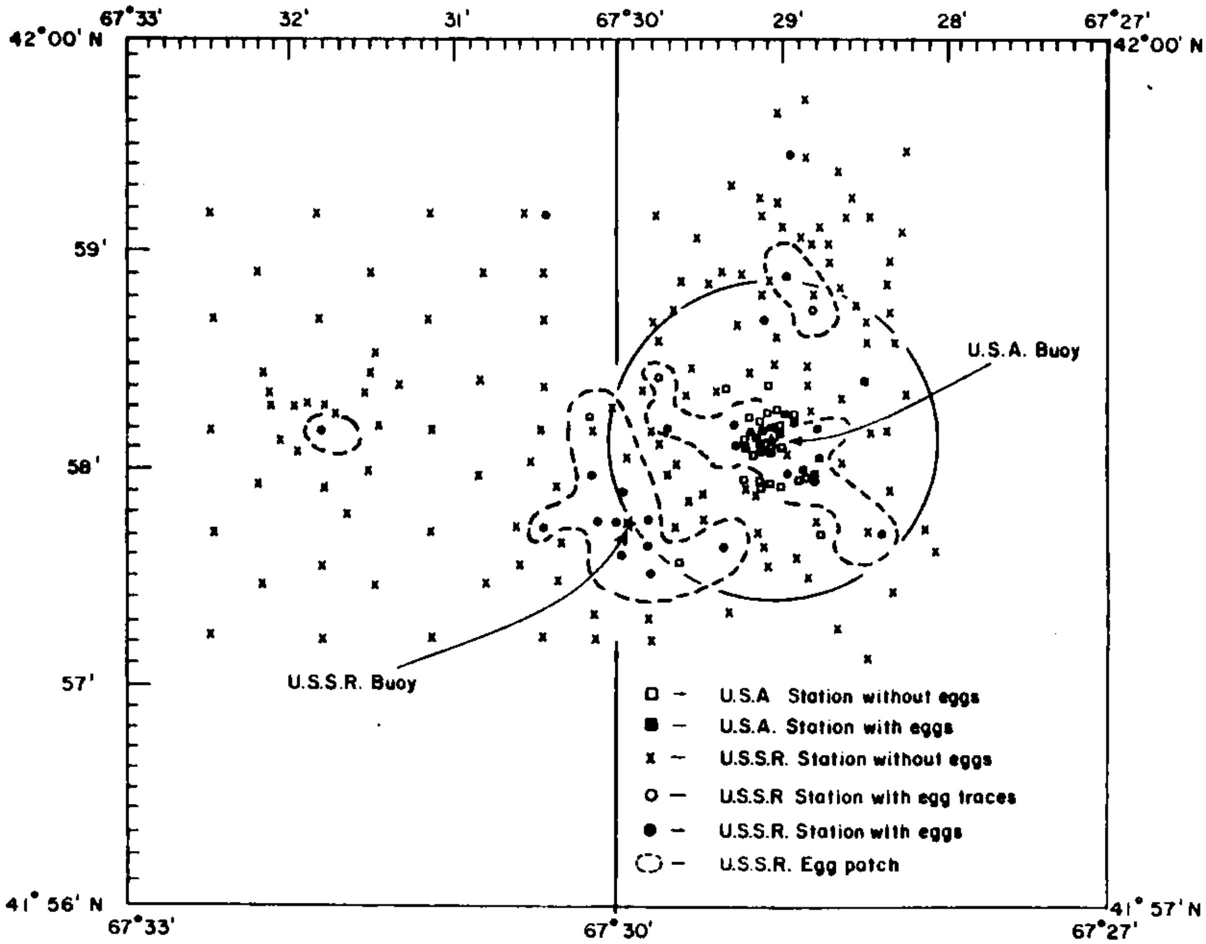

Fig. 3. The herring egg survey by the *Aliot* on 28-29 September, and 2-3 October, 1969 with the area of sampling of the *Albatross IV* shown by the circle.

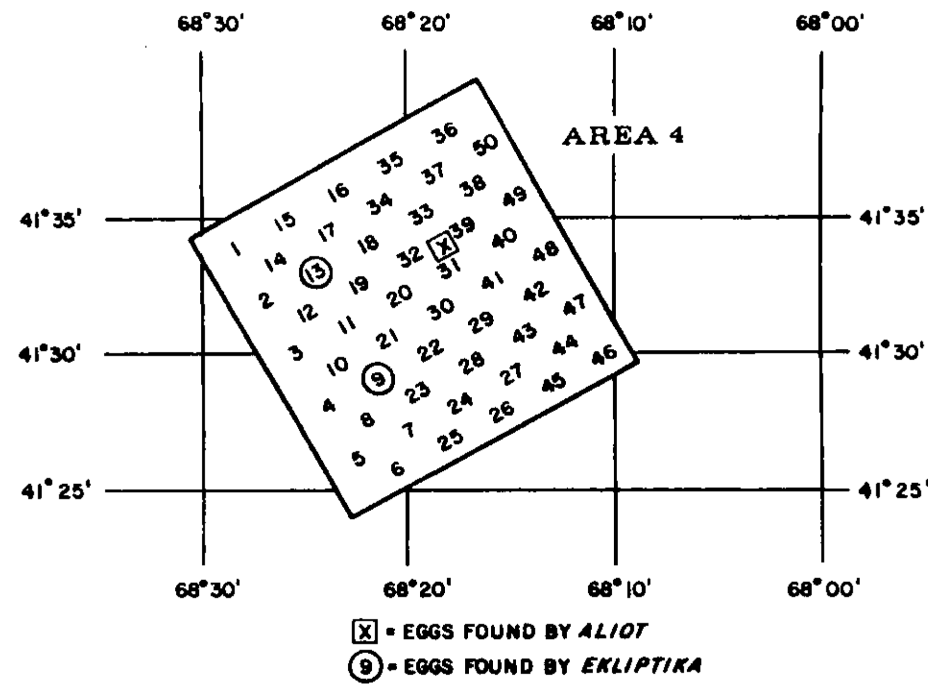

Fig. 4. The stations of the herring egg survey at Area 4 by the *Ekliptika* on 2-3 October, 1969.

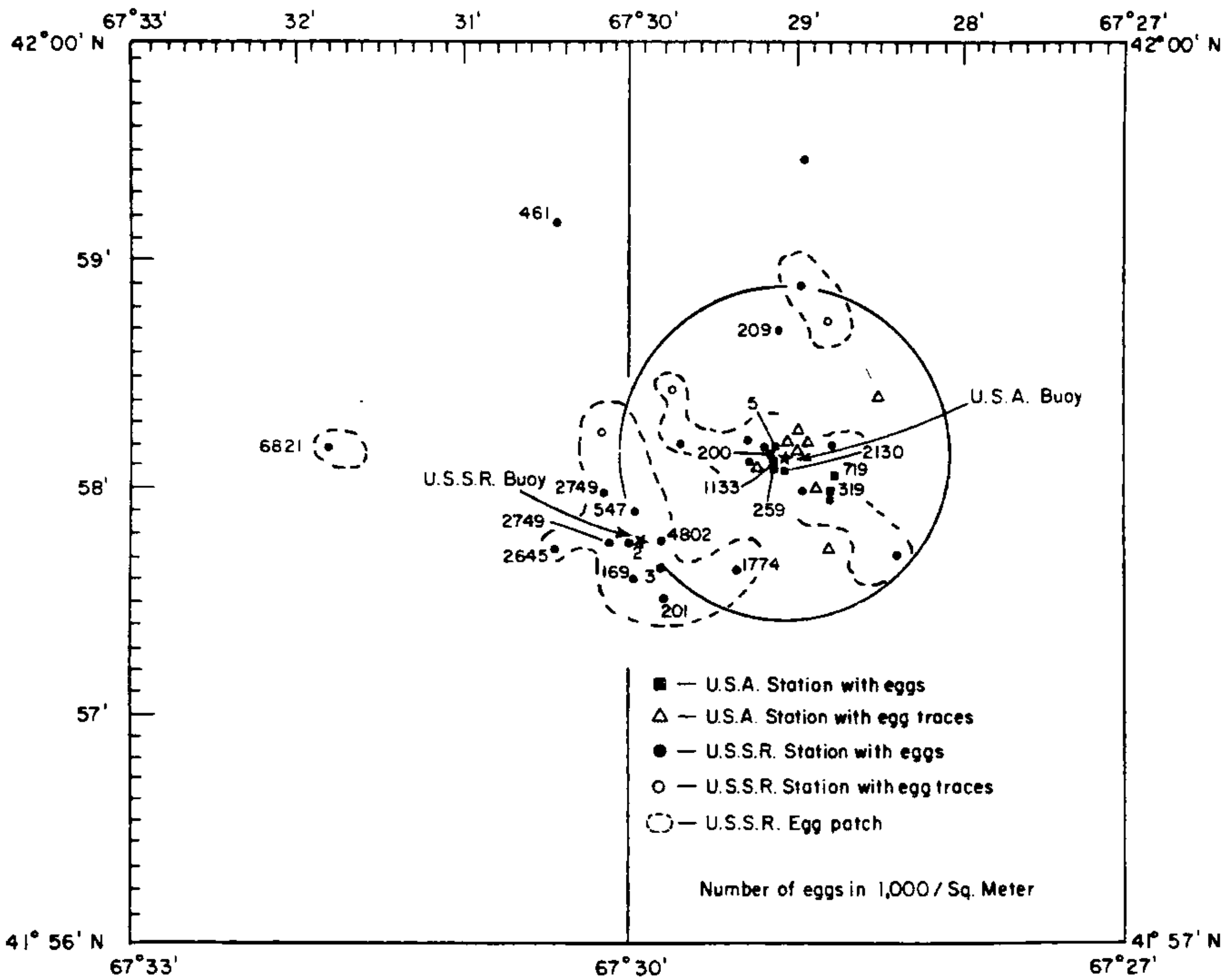

Fig. 5. The stations of the *Aliot* and *Albatross IV* where eggs were found with the number of eggs per square meter.

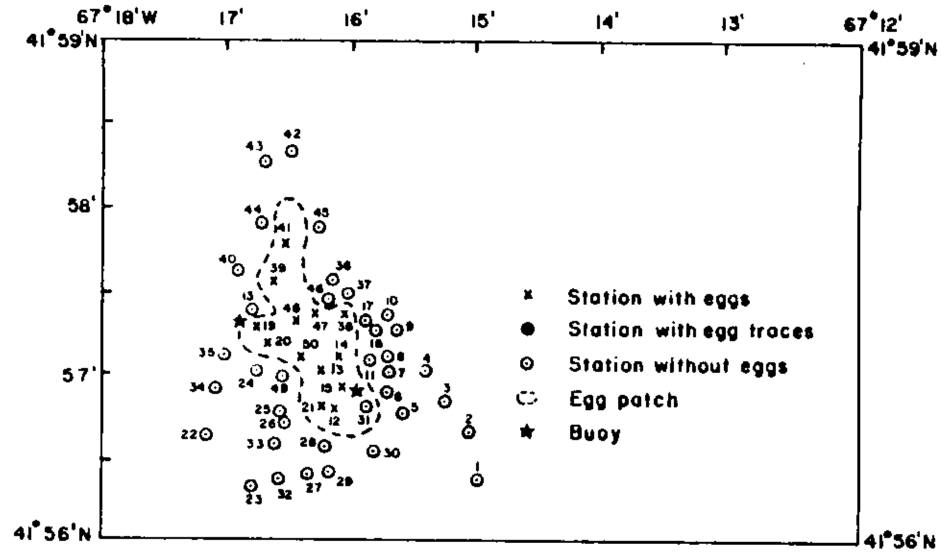

Fig. 6. The herring egg survey of the *Aliot* on 21 September 1969, in Area 2.

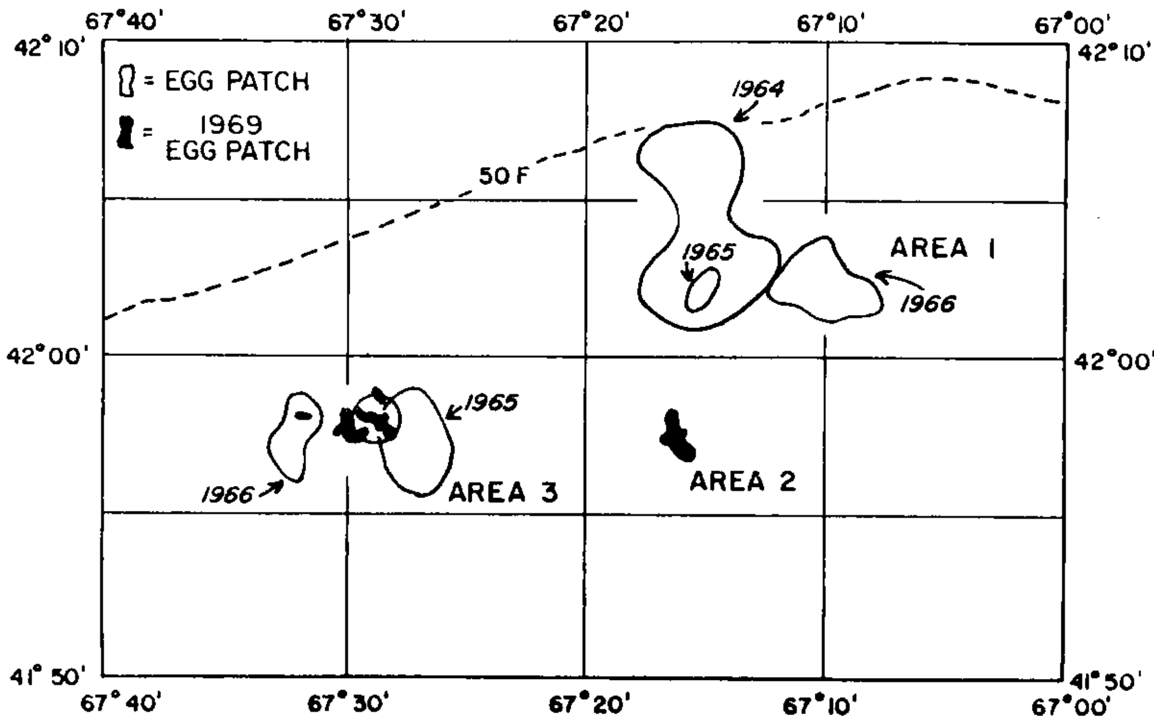

Fig. 7. A comparison of egg patch location and size in 1964–1966 and 1969.

16. Recent events in Canadian Atlantic herring fisheries[1]

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The Canadian Atlantic herring fisheries increased five-fold during the 1960's. This rapid expansion was accompanied by a change from the traditional fixed gear operation using weirs, traps and gillnets for food and bait herring to one dominated increasingly by highly mobile purse-seine (and very recently M.W.T.) fleets serving a new meal and oil industry concentrated in a relatively few ports of landing. These features of the new Canadian herring industry, and the rapidity of the expansion have made it difficult for details of the change to be fully documented. In particular, the system of recording herring 'landings' at points of sale and disposal rather than dealing with the catch location, a system that may be adequate for fixed gear fisheries, cannot cope fully with a fishery in which mobile units can switch rapidly from one area to another in its day-to-day operations.

The stock situation for herring of the western Atlantic is unusually complex and not well understood and changes in fishing area usually mean a change in the unit stock being exploited.

Despite these difficulties it has become clear that by the beginning of the 1970's there is justification for concern for the continuing success of the Canadian herring fisheries and this communication attempts to summarize the present situation on the basis of the admittedly incomplete information at present available.

Table 1 lists Canadian herring landings for the years 1961 and 1969 by ICNAF areas and divisions. The increase in landings began in Div. 4X in 1964 and 1965; in 1966 the Newfoundland fishery in Subarea 3 and Div. 4R began its period of expansion and in 1967 the Gulf of St. Lawrence fishery (4T) showed its first significant increase. (The earlier increase in 4T landings in 1962 in Table 1 represents the last stages of recovery of the herring stocks there from the effects of a fungal epizootic epidemic of the 1950's (Tibbo and Graham, 1963)).

Division 4X

There are two major Canadian fisheries in Div. 4X. On the New Brunswick side of the Bay of Fundy a long established weir fishery exploiting mainly 2-year-old 'sardine' herring (McKenzie and Tibbo, 1960) has been augmented recently by a purse-seine fishery. On the Nova Scotia southwest coast weir and gillnet fisheries have been superceded as the major fisheries by the new purse-seine fishery centred on the Lurcher-Trinity area.

[1] submitted to the 1970 Annual Meeting of ICNAF as Res. Doc. 70/78

Table 1. Total Canadian herring landings (1961-69 ICNAF Division - metric tons.)

		1961	1962	1963	1964	1965	1966	1967	1968	1969
4X	Nova Scotia	39,261	32,916	22,753	40,511	60,638	99,276	104,902	138,860	96,936
	New Brunswick	18,614	34,403	41,451	49,748	63,045	89,002	85,081	87,511	73,141
4X TOTAL		57,875	67,319	64,204	90,259	123,683	188,278	189,963	216,371	170,077
4W		1,977	1,788	2,161	1,868	1,364	1,199	1,028	1,206	6,154
4V[illegible]		789	749	526	411	281	143	296	239	750
4T		18,822	34,430	39,900	39,333	44,254	36,905	62,636	102,496	142,703
4S		57	85	47	31	47	78	67	55	44
4R		1,574	1,983	2,274	5,148	4,809	4,962	6,019	4,178)	
3		4,058	5,151	5,756	3,335	8,128	23,096	78,411	155,154)	167,308
5		-	144	-	636	30	47	6,532	35,171	8,339
GRAND TOTALS		85,152	111,649	115,868	141,021	182,596	254,708	344,972	524,870	495,375

The Nova Scotia coastal fishery exploits an autumn-spawning stock which is generally considered to be distinct from herring stocks to the south, in particular the Georges Bank autumn-spawning herring (Anthony and Boyar, 1968). The New Brunswick sardines have often been hypothesised as representing the progeny of these Nova Scotia adults but the evidence is by no means conclusive (Tibbo, 1968) and there is some indication that no direct relationship exists,between the two stocks on opposite sides of the Bay of Fundy (Iles, Res. Doc. 70/82). The two Fundy fisheries are, therefore, best treated separately.

Table 2 gives information on landings listed by gear type and for the period 1963-1969.

The Nova Scotia Fishery

In Fig. 1 the landings for the Nova Scotia seiner fleet are compared with those for all other gears combined. It shows that the increase in total catch has resulted from the new purse-seine fishery. There has been no marked change in the seasonal catch pattern; both the traditional weir and gillnet fisheries and the new seine fishery record most of their catch in the summer months (June to October). There has been a change in the size and age structure of the catch.

Size and age structure of the catch

The gillnet fishery exploited adult fish used for food, the common mesh size being 2 1/2 - 2 3/4 inches (63-69 mm). The weir fishery based on St. Mary's Bay and along the Fundy shore of Digby Neck caught, very largely, 'sardine' herring in their second year of life although adult fish are also caught on occasion more especially along the Fundy shore.

The purse-seine fishery developed specifically as an adult fishery concentrating on prespawning and spawning schools found in a relatively small area near the Lurcher and Trinity Shoals, and for most of the period of expansion adult fish predominated in the catch (Messieh *et al.*,1968). In 1968, 2-year-old herring were also caught in the summer in the Lurcher-Trinity area, although these were avoided by seiners, if possible, because they enmeshed in the nets. In 1969 the same year-class (1966), still predominantly immature, was caught in large numbers in the main fishing area; they made up about 50% of the catch in numbers and about a third of the total weight. This represents a new and possibly transient development. The 1966 year-class seems to be an unusually large one and in both 1968 and 1969 large, stable, concentrations of adult herring, capable of sustaining a fishery over a period of days or weeks, were much less in evidence than in earlier years. More effort was diverted in 1969 towards the more scattered, less densely crowded, but relatively abundant schools of the younger fish.

Table 2. Div. 4X landings by gear type for the two major fisheries.

* Estimated from total landings and gear-breakdown for the years 1966-1968.

		1963	1964	1965	1966	1967	1968	1969
Nova	Seines	9,880	20,568	31,564	88,901	96,992	123,866	62,602
Scotia	Gillnets	6,343	7,622	8,441	6,833	8,631	8,216	5,264
	Weirs & Traps	5,345	12,673	10,449	4,065	6,713	5,397	4,491*
	Mid-Water Trawl	-	-	-	-	805	1,381	1,478
	TOTAL	21,568	40,863	50,454	99,799	113,141	138,860	73,825
New	Seines	12,671	21,922	29,256	42,299	49,272	48,108	34,224
Brunswick	Weirs & Traps	29,279	27,337	33,685	39,605	35,931	39,403	31,901*
	TOTAL	41,950	49,259	62,941	81,904	85,103	87,511	66,125
	Unknown	1,691	1,657	12,650	943	1,115	466	820
	GRAND TOTALS	65,209	91,769	126,045	189,646	199,459	226,837	140,757

Fleet changes

Up to 1965 the seiner fleet was made up of about 20 small (60 ft) wooden vessels. Fleet expansion from 1965 to 1967 was very rapid and some 50 unites were added. These included about 20 units in the 50-60 ft range, the same number of boats in the 60-100 ft range and about 10 larger units up to 140 ft. Of these larger units three were midwater trawlers. At the same time larger seines were used by the whole fleet, from 200-300 fathoms X 50 fathoms rather than 100-150 fathoms X 15-25 fathoms. Only a few units have joined the Nova Scotia fleet since 1967, and these are all large steel boats and include both seiners and midwater trawlers.

Most of the fleet concentrate their effort in the Nova Scotia fishery but in 1969, after relatively poor fishing early in the season, seven of the larger units including three midwater trawlers transferred operations to the Gulf of St. Lawrence. Some annual visitors from the Newfoundland fishery also left early in 1969. Most of the Nova Scotia fleet land in one of three ports, Saulnierville, Yarmouth, and East Pubnico, but after July in the 1969 season about 20 small units landed their catch in New Brunswick and Maine ports. Offshore effort by the Nova Scotia fleet directed towards Georges Bank and the Massachusetts and Maine areas has been sporadic and never sustained. The Nova Scotia fishery is almost entirely an 'overnight' fishery, boats leaving in the late afternoon and returning next morning about 12 hours later.

Total catch and relative abundance

Landings from the Nova Scotia fishery increased from 1963 to 1968 but declined sharply in 1969. This decline was partly due to a reduction in effort but mainly the result of a decline in abundance.

Table 3 gives the results of the analysis of log book records of individual boats of known experience and capability. All of these boats are in the 50-70 ft range; under the prevailing conditions these smaller boats have outperformed the larger units on the basis of available catch statistics.

Table 3. Nova Scotia fishery. Seasonal catch data.
(Number of nights' fishing for the season in brackets.)

	1966	1967	1968	1969	1966	1967	1968	1969
Boat	Metric tons				Catch/night's fishing			
1	4271(70)	4605(70)	4244(64)	2697(66)	61.0	65.8	66.5	40.9
2	8100(70)	6646(63)	5800(70)	3000(50)	115.7	105.5	82.9	60.0
3	5501(68)	3500(55)	2449(51)	1589(53)	80.9	63.6	48.0	29.9
4			2615(64)	2098(54)			40.9	38.9
5			2795(48)	2472(65)			58.2	38.0
					Mean		59.3	41.5

For each boat the catch/night fell in 1969; boat 4 entered the fishery in 1968 as a relatively inexperienced unit and showed only a small drop in catch/night in 1969. The average decline between 1968 and 1969 is 30%, but when 1969 is compared with the years 1966 and 1967 a fall in catch/night of about 50% is indicated. If the 1969 catch of the 1966 year-class is discounted so that catches of adult fish only are compared, there is a 50% decline in the catch/night from 1968 to 1969.

The New Brunswick Fishery

The breakdown of landings by gear for New Brunswick for the years 1963-1969 is shown in Fig. 2.

The weir fishery extends from the US border to Saint John, about halfway along the western shore of the Bay of Fundy. Landings recorded from this fishery have not varied greatly over the period and, as with the Nova Scotia fishery, the increase in the New Brunswick fishery in the late 1960's is accounted for by the increased seiner activity.

The New Brunswick weir fishery has a long history (McKenzie and Tibbo, 1960) and exploits very largely 2-year-old 'sardine' herring (Messieh, *et al.*, 1968) on which a canning industry is based. It is a summer seasonal fishery (May to October) and since 1966 has been protected by the exclusion of purse seiners from the area during the main weir season.

The purse-seiner fleet fishing New Brunswick waters is made up of small boats based on Grand Manan and Campobello, two islands at the entrance of the Bay of Fundy. These join the Nova Scotia fleet during the summer 'closed' season in New Brunswick and seine on the New Brunswick side of the Bay during the early and late months of the year only, when they then exploit very largely 'sardine' sized herring. The increase in seiner landings for the New Brunswick section of the Bay thus involves an extension of the season and a higher degree of exploitation of young herring.

Little detailed information on the fishing operations and catch rates for this fleet is available however. Their traditional markets are in New Brunswick and a considerable proportion of their catch is transported across the Bay of Fundy from the Nova Scotia fishery to these markets. Weir catches in Nova Scotia are also shipped across the Bay, and much of the difficulty in assessing the degree of exploitation of the herring stocks in the Bay of Fundy is caused by this transfer of catches and the recording of an, at present unknown, proportions as New Brunswick fish.

It is for this reason that the decline in the New Brunswick catch in 1969 is thought to be more marked than is indicated in Table 2. The indications are that in 1969 the cross-bay traffic into New Brunswick was more marked than in earlier years, and certainly, records from individual weirs indicate a greater fall-off in weir catches than the 20% indicated in the table.

The Bay of Fundy fisheries for a long time were dominated by the New Brunswick weir fisheries and could then properly be described as 'juvenile' fisheries. The important effects of the recent spectacular increase in the Bay of Fundy herring fisheries have been (a) to shift the main centre of fishing activity to the Nova Scotia side of the Bay, and (b) to lead to a greater exploitation of adult fish.

The Nova Scotia stocks are generally considered to be biologically distinct from the Georges Bank herring complex (Anthony and Boyar, 1968) and any increase in their exploitation, whether of adult or juvenile stages, would not be expected to affect the Georges Bank stock situation. The parental stock of the New Brunswick 'sardine' is still in doubt, but even if they are Georges Bank stock, any effect of the increased exploitation of herring in New Brunswick waters in the mid 1960's would not be felt in the adult fishery until the late 1960's; two or three years would elapse before the 'sardine' recruit to the adult fishery.

While, then, a marked increase in the Fundy juvenile fisheries should be viewed with concern for the future, there is no reason to suppose that events in the Fundy fisheries are related to the decline in the Georges Bank stock during the 1960's (Studenetsky, 1969).

Division 4T, Gulf of St. Lawrence

Landing statistics for the Gulf of St. Lawrence herring fisheries covering the period 1933-1968 are listed and discussed by Tibbo *et al.* (1969). Total landings rose slowly and unevenly from 20,000 metric tons in the early 1930's to about 40,000 metric tons in the early 1950's but an epidemic fungus epizootic resulted in a sharp decline in the late 1950's and was followed by recovery in the early 1960's. The epizootic appeared to affect spring spawning stocks more than autumn spawners (Tibbo and Graham, 1963) but the basic structure and organisation of the fishery and its reliance on inshore gear, mainly gillnets, and fishing spawning concentrations was not altered.

The whole picture has been transformed in recent years since purse seiners became active in 1966. Table 4 compared purse-seine landings with total landings and demonstrates that the dramatic increase in the Gulf herring fisheries has involved seiners almost entirely (although midwater trawlers are now becoming active).

The seasonal distribution of effort and landings has also changed. As recently as 1965 the Gulf fishery was very largely a spring fishery and over 80% of landings were recorded in April, May and June, much of it from the Magdalen Island spring-spawner fishery. In 1968 only 30% of the total Gulf landings were made in these months and in 1969 only 20%. Monthly landings for these years are given in Fig. 3 to illustrate these changes. It would appear that the Magdalen fishery is smaller both absolutely as well as relatively. It is also clear that the 1969 increase occurred in the two months July and August; catches for September and later were unchanged from 1968.

Table 4. Div. 4T: Gulf of St. Lawrence. Landings (metric tons) for purse-seiners compared with total landings.

	1963	1964	1965	1966	1967	1968	1969
Seine landings	10	5	28	2,249	17,283	46,647	110,237
Total landings	39,900	39,333	44,254	36,905	62,636	102,496	142,603
Seine landings as % total	-	-	-	6.09%	27.6%	45.5%	77.3%

Log book records are available for a section of the purse-seine fleet operating in the Gulf and indicates information for individual boats which have taken part in the fishery from its beginning. For recording purposes the Gulf is divided into areas shown on the map (Fig. 4). Scrutiny of log books indicates that some of these areas can be subdivided into divisions which represent significant changes in seining activity.

Area 115 includes the Magdalens and extends towards the entrance of the Gulf. Three fishing areas can be delineated. The area of the Magdalen Island spring spawning fishery which is an inshore fishery centred on Pleasant Bay and in which seiners now take part, the area between Cape North and St. Paul Island off Cape Breton Island, and the area centred on Bird Rocks north of the Magdalens and near the edge of the Laurentian Channel.

Area 109 includes American Bank off the Gaspé peninsula the major centre of summer seining operations, but besides this offshore fishery in 109 there is a significant shift in operations inshore into as shallow water along the Quebec shore as can be fished by seiners. An "inshore" area of 109 is therefore treated separately.

The seasonal distribution of purse-seiner effort has been followed by tabulating the number of days successful fishing in each of the log book areas and divisions for fortnight periods throughout the year. Results from the logs of about a dozen boats are given in Table 5.

The overall picture that emerges is of a migration of fish into the Gulf beginning in late April and an exodus which begins in September. The data presented in the table together with information given in log books under the heading 'remarks' allow the following hypotheses to be suggested.

1) There is an influx of herring through the southern entrance of the Gulf in April and the timing of this movement makes it entirely possible that it involves Chedabucto Bay fish (see below) and/or herring recorded as caught in quantity in the early months of the year on Banquereau as moving towards Cape Breton in the spring (Konstantinov and Noskov, Res.Doc. 70/20).

Table 5. Seasonal and area distribution of successful fishing in the Gulf of St. Lawrence.

Area		April		May		June		July		August		Sept.		Oct.		Nov.		Total
		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	
116	Entrance		5	10														15
	Bird Rocks		9	5		4									6	9	2	35
	Magdalen Is.		17	12	7	1												37
112	Orphan Bank						4					39	20					63
109	American Bank			8	15	18	51	91	51	49	64	49	68	5	6			476
	"Inshore"						2	9	71	39	14	1	1					137
110	Bay of Chaleur			1	2				19	9	3	1						35
107	St. Lawrence Est. (South Shore)			2			1	2	14	29	13	3	1					65
115) 111)	Southern Gulf				2		4											6
			31	38	26	23	62	102	155	126	95	93	90	5	12	9	2	

2) This does not exclude the possibility that Newfoundland fish also move into the Gulf; a westerly movement of herring along the south Newfoundland coast towards Port aux Basque in late winter is followed into the Gulf towards St. Pauls Island and Bird Rocks by seiners operating in the Newfoundland fisheries.

3) The Magdalen spring spawners could come from either Newfoundland or from the general Banquereau area. Records of spent fish in the Bird Rocks area and to the northwest along the edge of the Laurentian Channel suggests that they move into the Gulf to feed after spawning.

4) The main migration route appears to be along the southern edge of the Laurentian Channel and movement into the Gulf is rapid; no large stable populations have been found in the early part of the season at Orphan Bank.

5) American Bank is a major feeding area in the late spring and throughout the summer; there is a possibility that herring "spill over" southward from here to move towards Prince Edward Island and the New Brunswick shore.

6) The American Bank fishery exploits both feeding herring and also pre-spawning herring which are followed inshore as they move to their spawning grounds. This accounts for the "inshore" fishery near American Bank itself and those in the Bay of Chaleur and the North Gaspé peninsula.

7) In late summer and fall herring move towards Orphan Bank and the area of distribution of fishable concentrations is extended. Movement out of the Gulf in the fall is therefore not as rapid as is the influx although both movements appear to follow the southern edge of the Laurentian Channel.

There seems to be little doubt that herring stocks fished in the summer in the Gulf of St. Lawrence are exploited also by fisheries outside the Gulf although the complexity of the stock situation will make it difficult to identify individual components. Canada has already initiated programs to follow these suspected movements in and out of the Gulf by tagging herring at Newfoundland (March 1970) and at the Magdalen Island spring spawning fishery (May 1970). Other tagging operations are planned for 1970. The tagging of winter Banquereau fish is desirable.

Catch rates for 1968 and 1969 by months are listed in Table 6 for individual purse seiners. Each of the boats represented, fish similar gear and operate in a similar way. The data are limited but there is no indication of any great change in catch rate between the two years. For July and August, peak months for the fishery, the catch per day's fishing is almost identical so that unless there has been a large change in availability or in efficiency no major change in abundance has occurred and the increase in catch in 1969 represents the effect of an increase in effort.

Table 6. Monthly catch rates for individual purse-seiners in the Gulf of St. Lawrence as metric tons per day's fishing and as metric tons per set (in brackets).

	1968				Mean	1969			Mean
May		40 (25)		155 (99)	97 (62)				
June		63 (31)	42 (37)		52 (34)	48 (23)	60 (44)		54 (33)
July	147 (51)	107 (35)	72 (34)	146 (49)	118 (42)	122 (46)	115 (55)	129 (66)	122 (56)
August	111 (50)	84 (35)	111 (39)	153 (60)	115 (46)	122 (58)	111 (62)	125 (67)	119 (62)
September	175 (76)	109 (68)	122 (67)	127 (69)	133 (70)	104 (78)	115 (90)	73 (53)	97 (74)
October	81 (81)		102 (102)	72 (36)	85 (73)				
November	184 (85)			76 (51)	130 (68)				

The diversion of effort from the Nova Scotia fishery to the Gulf in 1969 is a trend which is likely to continue, for catch rates in the Gulf are high, but the extent to which Gulf stocks can withstand extra effort is unknown, as is the degree to which these stocks are exploited outside the Gulf fisheries.

Div. 4W

The occurrence of herring in concentration in the Chedabucto Bay area, between Nova Scotia and Cape Breton Island has been known for some time. In 1969 a localized fishery on these herring developed involving about a dozen units, including five midwater trawlers. From mid-January to late March an estimated 20,000 tons of herring from the Chedabucto Bay fishery were landed at Yarmouth, Nova Scotia. In addition herring were supplied to a local reduction plant at Canso.

The fishery in 1970 was considerably smaller, although detailed catch data are not yet available. Samples of herring from the 1970 fishery indicated that a wide range of size occurred in the area. One-year and two-year old herring were found inshore but the bulk of the fishery was made up of mature fish in the spent or spent-recovering stages.

The distribution of midwater trawler effort in the general area from late fall 1969 to March 1970 indicated a possibility that the Chedabucto Bay area may well be an overwintering area for Gulf herring.

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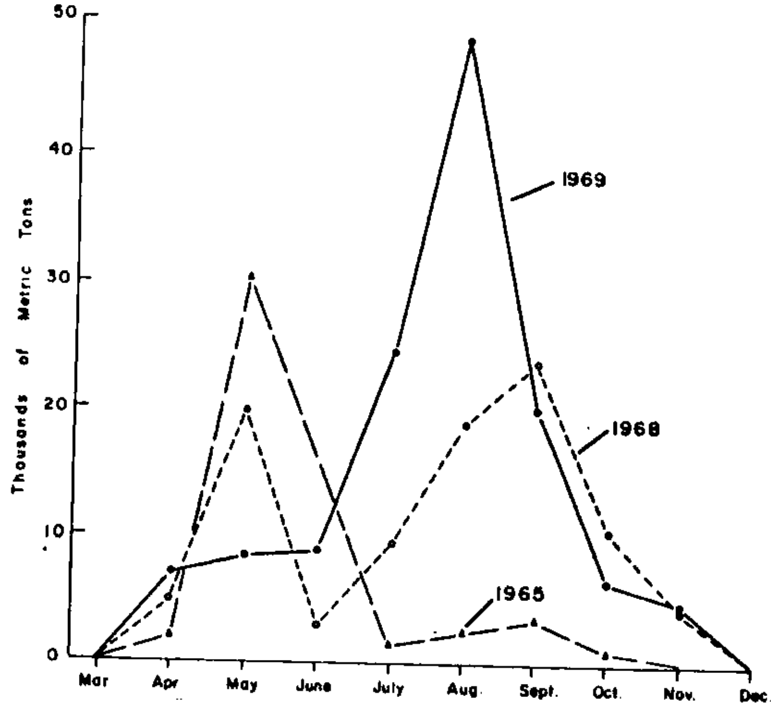

Fig. 3. Seasonal herring landings in 4T (Gulf of St. Lawrence) for 1965, 1968 and 1969.

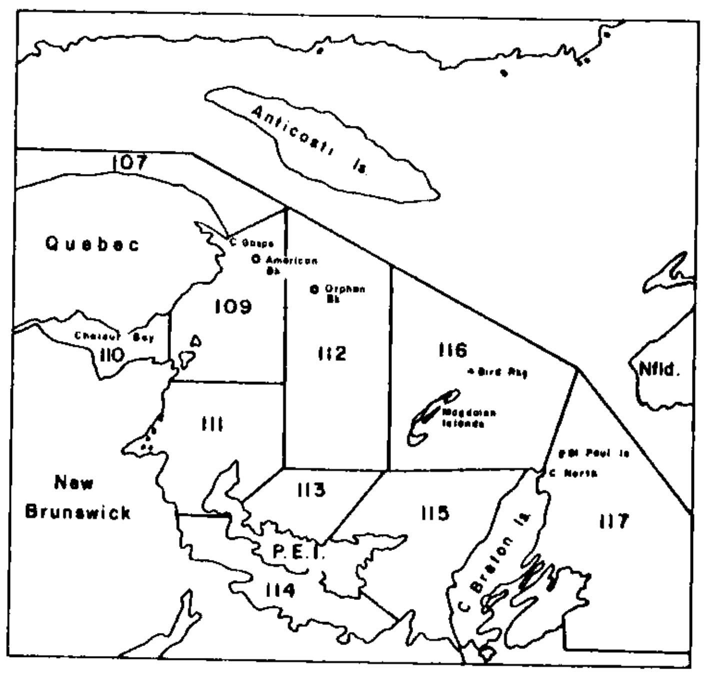

Fig. 4. Map of Gulf of St. Lawrence showing fishing areas.

17. Vertebral numbers of the Bay of Fundy herring and the origin of New Brunswick sardines[1]

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The Bay of Fundy supports two major herring fisheries, one on the New Brunswick side which is based largely on two-year-old "sardines", and one near the southwest coast of Nova Scotia exploiting both juveniles and adults (Iles and Tibbo, 1970).

Data on vertebral numbers for Nova Scotia adults have been presented and discussed by Anthony and Boyar (1968) but none has been published for juvenile or sardine herring from either fishery. Sampling at the St. Andrews Biological Station in 1969 for vertebral numbers of herring from both fisheries has given enough information to pose questions of interest and importance concerning the origins of and relationships between the two Fundy herring groups and a preliminary account is now presented.

Herring were x-rayed using a Faxitron 805 "soft" ray unit and counts were made on the negative films which are available as permanent records at St. Andrews.

The urostyle is not included in the count; individuals showing vertebral anomalies were excluded from the analysis of the data.

Monthly distributions and mean vertebral numbers for the 1967 "sardine" year-class in the 1969 samples are listed in Tables 1a and 1b for the two areas. Table 2 gives the data on which a Z-test was based to determine the significant between the grand mean vertebral count shown in Tables 1a and 1b.

Table 1a. Monthly distribution of vertebral numbers for the New Brunswick 1967 herring year-class.

Month	Number of Vertebrae							
	53	54	55	56	57	58	Total	Mean
January	-	12	178	114	7	-	311	55.373
February	1	33	332	247	12	-	625	55.378
March	-	21	201	110	7	-	339	55.304
April	2	29	316	209	11	2	569	55.359
May	-	34	375	244	11	1	665	55.353
June	-	13	156	96	8	-	273	55.363
July	-	31	304	203	7	-	545	55.341
August	1	34	253	140	5	1	434	55.270
September	-	29	410	284	17	-	740	55.391
October	-	21	197	143	10	1	372	55.390
November	-	4	18	21	1	0	44	55.432
TOTAL	4	261	2740	1811	96	5	4917	55.356

[1]Submitted to the 1970 Annual Meeting of ICNAF as ICNAF Res.Doc.70/82

Table 1b. Monthly distribution of vertebral numbers for the Nova Scotia 1967 herring year-class.

Month	Number of Vertebrae							
	53	54	55	56	57	58	Total	Mean
March	-	6	70	69	1	-	146	55.445
April	-	6	74	65	6	-	151	55.470
May	-	10	79	95	11	-	195	55.549
June	2	3	47	45	2	1	100	55.450
TOTAL	2	25	270	274	20	1	592	55.486

Table 2. Z-test for the significance of the difference in mean vertebral count between the New Brunswick and Nova Scotia 1967 year-class.

	n	Mean	SD	
New Brunswick	4917	55.3557	0.6208	Z=4.9242
Nova Scotia	592	55.4864	0.6579	

The difference is highly significant statistically and there is little doubt that the 1967 sardine year-class in the Bay of Fundy is made up of two major components at least. It is conceivable that these represent the segregation of progeny from a single parental stock, but although this possibility is being examined, it appears to be unlikely and much more probable that the two sardine groups have different parental origins.

This hypothesis tends to be supported by vertebral numbers available for other year-classes, presented in Table 3, together with the information for the 1967 year-class itself.

Table 3. Comparison of mean vertebral numbers for Nova Scotia and New Brunswick herring year-classes.

	New Brunswick		Nova Scotia	
Year-class	n	Mean VS	n	Mean VS
1967	4417	55.356	592	55.486
1966	800	55.383	144	55.479
1961-65			408	55.463
1960			964	55.514
1959	1036	55.346		
1958	1916	55.391	650	55.554
1957	1300	55.450		
1956	2389	55.337		

Note: The 1966 year-class for both areas was sampled in 1969; the Nova Scotia adult year-classes (1961-65) for the 1969 samples are combined. The Nova Scotia 1960 and 1958 year-classes were sampled as adults by Anthony and Boyar (1968). The 1956-59 New Brunswick data are from "sardine" samples examined in the years 1958 to 1961 at St. Andrews. These latter data are provisional, but are unlikely to be modified to any significant degree.

Higher mean vertebral numbers are found at Nova Scotia for each of the three year-classes for which comparison can be made. The mean vertebral number for the 1957 New Brunswick year-class is considerably higher than those of all of the other year-classes but, despite this, the data in Table 3 suggest strongly that persistent differences exist and that the possibility that two different stocks are involved in Bay of Fundy fisheries is real.

The origin of the Bay of Fundy New Brunswick sardines was discussed by Tibbo (1968) who concluded that, while the Nova Scotia spawners was currently considered to be the major contributors, the problem was still not solved, and that the Georges Bank spawners could not be excluded as possible parental stock.

The data presented here both makes it less likely that the Nova Scotia spawners are regular, major contributors to the New Brunswick sardine population and more likely that the Georges Bank spawners are, for the low mean vertebral numbers of most of the New Brunswick sardine year-classes, are similar to values given by Anthony and Boyar (1968) for Georges Bank herring. The evidence is by no means conclusive but does suggest that possible mechanisms whereby Georges Bank progeny could enter and remain in the western side of the Bay of Fundy (and as distinct from the eastern side) should be investigated.

In earlier discussion on the origin of "sardine" herring in the Bay of Fundy, emphasis has been laid on the question of the larval dispersal that "non-tidal" drift would tend to generate. A counter-clockwise current system in the Bay of Fundy whereby water, entering along the eastern Nova Scotia side, passes across the Bay at about half-way in and leaves the Bay along the western (New Brunswick) side, is well documented although seasonal and year-to-year variation may be considerable, as may be the extent to which the circulation is "closed" (Bumpus and Lauzier, 1965). Perhaps more consideration can now be given to the possibility that the sardine concentrations in New Brunswick waters result from active upstream movement of larger post-larval herring from the southwest. If herring at this stage of the life-history are both negatively rheotactic and "shore-seeking" then their accumulation along the western shore as far as Saint John, the "cross-over" point, and which represents also the inner limit of the New Brunswick sardine fishery, might then be explained. More detailed information on the distribution and movements of the one-year-old herring, the "brit" stage would be desirable.

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SECTION G
REDFISH

17. Depth distribution of "Beaked" Redfish (*Sebastes mentella* Travin) on Flemish Cap Bank[1]

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Long-term intensive fisheries for "beaked" redfish, *Sebastes mentella*, Travin, on Kopytov, Rozengarten, Anton Dohrn and Flemish Cap Banks did not affect the age-size composition of redfish (Sorokin, 1963; Surkova, 1957; Konstantinov, 1966). The age-size composition of the fished part of the "beaked" redfish stock is stable even if a decline in the total catch in the mean catch per trawling hour or a reduction in the fishing period or a full cessation of the fishery is apparent. Surkova (1962) and Richter (1965) suggest a probable tendency to rejuvenation of the "beaked" redfish stock on Flemish Cap Bank under the influence of the fishing. But the decrease in the average age is rather attributed to movement of the fishing fleet to shallower depths or to changes in the season and area of the fishery (Savvatimsky, 1965; Chekhova, 1964).

The question of the distribution of "beaked" redfish according to depths on the continental slope of the North Newfoundland Bank was discussed by Sidorenko (1967). It was stated for the southern Flemish Cap Bank that in August the mean length of redfish males and females was decreasing (Savvatimsky, 1963) with depth.

This paper aims to show the peculiarities of differences in age-size composition of "beaked" redfish according to depths and seasons.

The annual cycle of mature redfish is broken down into the following periods:

1) Extrusion of larvae and beginning of the summer feeding - March-June.
2) Summer fattening and copulation - July-October.
3) Wintering and maturation of females - November-February.

March-June

Redfish males do not migrate any great distance. The specimens of 33-35 cm in length at an age of 12-14 years predominate at all depths from 201 to 700 m (Fig. 1, 2).

The changes, with depth, in the length composition of females, are more pronounced. Large female specimens of 37-39 cm long prevail at a depth of 201-300 m. Although the main length-group of 34-37 cm remains in the 301-700 m depth zone, the proportion of female specimens of 37 cm long increases at depths greater than 501 m. As a consequence of this, the average length

[1] submitted to the 1970 Annual Meeting of ICNAF as Res. Doc. 70/47.

increases with the increase in depth from 501 m (Table 1). Changes in age composition with depth are in agreement with those in length composition. The proportion of male specimens 13-14 years of age and females 14-15 years of age increases with depths greater than 501 m.

July-October

During the period of summer fattening there is an even distribution of redfish with depths from 301 to 600 m (Table 1). The age-size composition is almost the same at all the depths, although older female specimens of larger sizes keep to a depth of 201-300 m (Fig. 1, 2). The number of large and older redfish increases with depths greater than 601 m.

In August when redfish are moving from great depths to nearer the surface a series of trawl hauls was made at 201-300 m, 301-400 m, 401-500 m, 501-600 m. These hauls showed that the predominant age and size of male and female specimens decreased with depth at a depth of 301-600 m.

Thus, July-October may be characterized in general as a period of a relative stability in the age-size composition at all depths down to 600 m inclusive. The migration of redfish and differentiation of the age-size composition is still possible at the beginning of the period. This was observed in August and was also noted by Savvatimsky (1963). The predominating length and age of redfish changes from the depth of 601 m: the deeper waters the larger redfish.

November-February

During this season the relationship between the redfish length, age and depth is most clearly marked (Fig. 1, 2) and becomes apparent from a depth of 401 m.

Analysis of the distribution of redfish in each season showed that the relationship between length, age and the depth of "beaked" redfish on the Flemish Cap Bank is distinctly marked throughout the year. In July-October it is apparent deeper than 601 m and in November-June deeper than 401 m.

It is evident from Table 1 that the greatest number of trawling hours was in March-June at a depth of 501-600 m, in July-October at a depth of 401-500 m, in November-February at a depth of 301-400 m. In November-February when fishing for cod at a depth of 201-300 m, redfish were only taken as a by-catch. At all depths mentioned, redfish males with a mean length of 32.9-33.3 cm and females with a mean length of 34.7-34.9 cm were caught.

Thus, throughout the year, redfish of 33-35 cm in length were moving along the slope of the bank. The commercial fleet followed their seasonal movement changing their trawling depth and therefore, over the span of the year, the fleet took redfish of the same size. This explains, to some extent, why, after some years of heavy exploitation of the fishing banks, the redfish catches were declining while the age-size composition was stable.

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Table 1. Fishery and the mean length of *Sebastes mentella*, Travin, at different depths on Flemish Cap Bank.

Depth (m)	March-June				July-October				November-February			
	Number of trawl hours	Catch per trawl hour (centner)	Mean length, (cm) males	Mean length, (cm) females	Number of trawl hours	Catch per trawl hour (centner)	Mean length (cm) males	Mean length (cm) females	Number of trawl hours	Catch per trawl hour (centner)	Mean length (cm) males	Mean length (cm) females
201-300	61	9	33.8	37.2	2668	8	32.9	36.4	4004	6	35.2	35.3
301-400	701	21	33.8	35.8	5626	15	32.7	34.3	1258	11	33.3	34.9
401-500	1843	22	32.9	34.9	11501	18	33.1	34.7	879	13	34.2	36.7
501-600	3042	25	33.3	35.1	189	16	33.6	35.1	1052	11	35.2	37.7
601-700	103	25	34.3	36.3	25	6	35.6	38.0	63	23	35.6	38.0
701-800	-	-	-	-	-	-	38.7	38.8	-	-	40.4	40.4

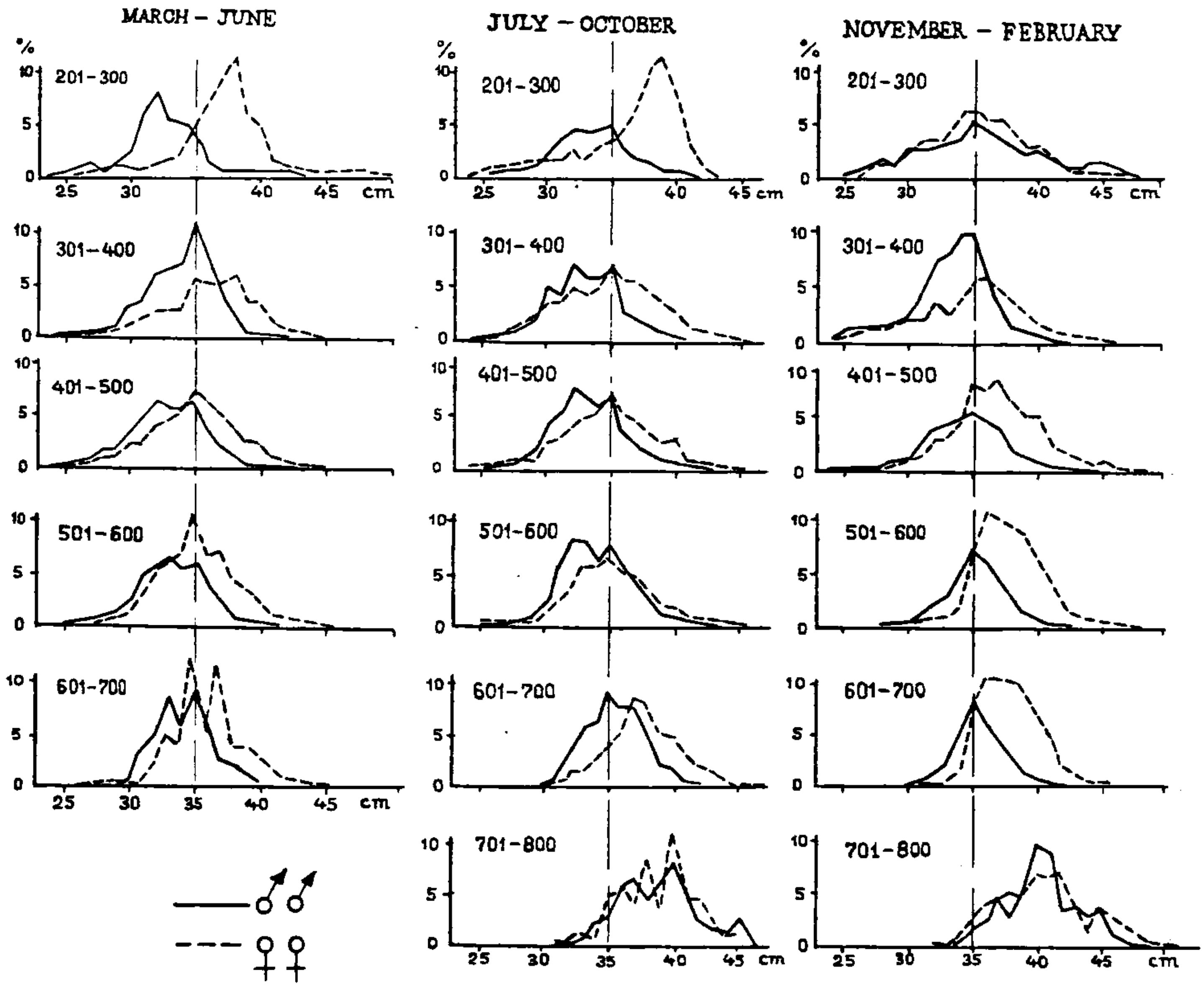

Fig. 1. Length composition of male and female "beaked" redfish on Flemish Cap Bank at various depths during various periods of the year.

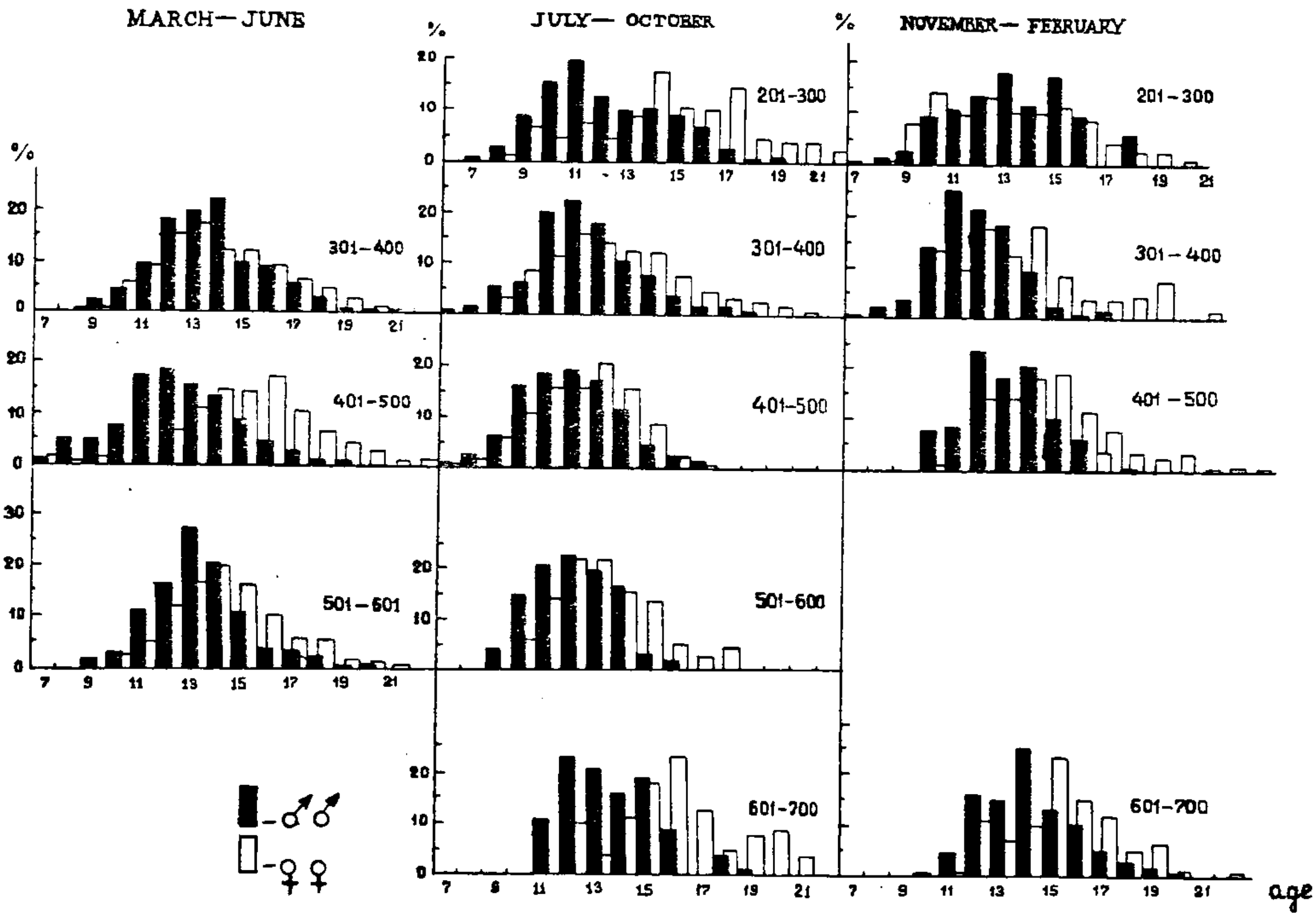

Fig. 2. Age composition of male and female "beaked" redfish on Flemish Cap Bank at varying depths during various periods of the year.

SECTION H
GROUNDFISH SURVEY

18. USA-USSR cooperative Groundfish Survey, Autumn 1969[1]

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Introduction

The 1969 cooperative groundfish survey was the third survey of the series begun in 1967 with the principal objective of developing more accurate abundance indices for groundfish. Joint groundfish studies in 1969 were conducted on the USA research vessel *Albatross IV* and the USSR scouting vessel *Ekliptika* during the period 8 October - 28 November, the area from Cape Hatteras to Georges Bank was again surveyed jointly as in 1968 and operations were further extended to the Nova Scotian shelf.

In this document we present a brief summary of the 1969 joint operations and some results of fishing power comparisons between USA and USSR trawls, and catch per haul statistics among areas and year. Analysis is limited to a few selected species. A comprehensive analysis of the US-USSR joint studies still remains to be done.

Methods

Station allocation for the Cape Hatteras to Georges Bank segment followed exactly the same stratified random sample design used in the 1968 joint survey (Lux, *et al.*, 1969). Details of this method, and the methods of sampling catches and processing data were given by Grosslein (1968). The same principles were used in stratification, allocation of stations, and sampling catches, on the 1969 survey of the Nova Scotian Shelf.

As in past cooperative ventures there was partial exchange of personnel and close cooperation between the scientific groups on the two vessels. After completion of the joint groundfish studies, there was a complete exchange of data.

Albatross IV, a stern trawler, again used the #36 trawl towed at 3.5 knots which has been standard for USA groundfish surveys; specifications of the #36 trawl were as given by Grosslein (1968), except that ground cables were not used. *Ekliptika*, a side trawler, used both the #36 trawl and a 24.6 m trawl towed at 3.7-3.8 knots, but with various rigging for different

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parts of the survey as described below. The 24.6 m trawl is basically similar in design to the 27.1 m USSR trawl used by the Soviet vessels in 1967 and 1968, except that the 24.6 trawl is a larger net, with a larger square and overhang than the 27.1 trawl. The footrope of the 24.6 is about 45% longer than the footrope of the 27.1 trawl, whereas the headropes of the two USSR trawls are nearly the same. Rigging of the 24.6 trawl for most of the 1969 operations was similar to that for the 27.1 trawl in 1968. Complete specifications of the 24.6 m trawl will be described in a later report. Measurement of the mouth area of the 24.6 m trawl, while towing, has not yet been made.

As in the past surveys, bathythermograms were taken at each trawl station and at selected locations along the cruise track. In addition *Albatross IV* obtained samples of fish eggs and larvae at each trawl station with a step-oblique plankton tow from 50 meters.

Cape Hatteras to Georges Bank

The area from Cape Hatteras to Georges Bank was surveyed jointly by the two vessels during the period 8 October - 8 November, and included the same sampling strata surveyed in 1968 (Fig. 1). *Ekliptika* used the 24.6 m trawl without rollers on this segment of the 1969 survey.

Albatross IV completed 194 trawl stations and *Ekliptika* occupied 120 stations, of which 13 were hauls with the two vessels towing side-by-side (Fig. 2). Frequent tear-ups and large catches with the 24.6 m trawl, plus an unusual amount of rough weather, made operations slower on *Ekliptika* and required elimination of scheduled stations particularly near Cape Hatteras. On this segment of the 1969 survey, *Ekliptika* used oval door of 3.5 m^2.

Nova Scotian Shelf

With the help of R.G. Halliday, Fisheries Research Board of Canada, St. Andrews, New Brunswick, the Scotian Shelf was subdivided into 30 sampling strata whose geographic and depth boundaries ($\leq$ 50, 51-100, 101-200 fathoms) were related to fish distribution (Fig. 3). Sampling strata 31 and 32 are identical with those used in past surveys by *Albatross IV*, and the remainder, with a few minor exceptions, follow the scheme suggested by Dr Halliday and discussed with the authors prior to the survey by *Ekliptika*. The areas north of Banquereau and those labelled "mixed depths" were excluded from the survey because of their complex nature and lack of time.

The original cruise plan called for both vessels to survey jointly the Browns-LaHave area, and then for *Albatross IV* to complete the remainder of its standard fall survey in the Gulf of Maine, and *Ekliptika* to finish the Scotian Shelf. Refuelling problems interrupted this plan and the vessels operated independently although there was an exchange of two scientists from each vessel during most of this phase.

Albatross IV made 22 hauls in its standard sampling strata in the Brown-LaHave area during the period 15-18 November (see Fig. 2), and then completed the rest of the Gulf of Maine (stations and strata for this segment not shown). *Ekliptika* began its survey near Sable Island, proceeded eastward to Banquereau and then returned westward as far as LaHave Basin within the period 13-27 November. Attempts to use the 24.6 m trawl without rollers resulted in frequent and severe damage, and thus most of the 66 stations completed during this segment were made with a USA #36 trawl fitted with 40 m ground cables, and using 3 m^2 oval trawl doors (Fig. 4). The remaining 28 stations for *Ekliptika* in the Browns-LaHave area were completed during the period 1-10 December (Fig. 4). On the first haul of this series, all but the rollers and floats of the #36 trawl were lost. For the remaining 27 stations a 24.6 m trawl was used rigged with the rollers from the #36 trawl; no serious tear-ups were experienced with this combination.

Results

Fishing Power Comparisons

As was expected, the 24.6 m trawl made considerably larger catches than the #36 trawl and comparisons with 1968 suggest that the 24.6 trawl also has greater fishing power than the 27.1 trawl. The percentage frequency distribution of catches for the three trawls clearly show a much higher frequency of large catches by the 24.6 m trawl (Table 1). In the area from Cape Hatteras to Nantucket Shoals (strata 1-8, 61-76) about 45% of the catches with the 24.6 m trawl exceeded 1,000 pounds, as compared with 7% for the 27.1 m trawl in 1968, and 1% and 10% in 1968 and 1969 respectively, for the #36 trawl. On Georges Bank (strata 9-25) catches in excess of 1,000 pounds accounted for 14% of the 24.6 m hauls as compared with 2% for the 27.1 m trawl in 1968, and 0% for the #36 trawl in both 1968 and 1969 (Table 1).

Table 1. Percentage frequency distributions of total catches (lbs.) by USA and USSR trawls, in two strata sets in 1968 and 1969.

Total catch	Strata 1-8, 61-76				Strata 9-25			
	1968		1969		1968		1969	
(lbs)	#36	27.1 m	#36	24.6 m	#36	27.1 m	#36	24.6 m
≤ 500	90	78	87	42	97	92	98	65
501-1000	9	14	6	11	3	6	2	20
1001-2000	1	5	3	22	--	--	--	10
2001-4000	--	2	3	14	--	2	--	4
> 4000	--	--	1	10	--	--	--	--
Total number hauls	100	78	98	62	90	65	89	49

The basic similarity in the catch frequencies for the #36 trawl in both years, and the fact that no major change in species composition was observed, suggest that the differences between the frequencies for the 27.1 and 24.6 trawls reflect real differences in fishing power, and not a difference in availability of fish between years.

Another comparison of the fishing power of the 24.6 and #36 trawls was provided by 13 pair-tows (side-by-side hauls) made at various locations during the 1969 joint survey, two to five tows per location (see Fig. 2). Ratios of total catches for the four sets of pair-tows show that the 24.6 m trawl caught three to five times the weight of fish taken by the #36 trawl in each set, although species composition varied widely among sets (Table 2). With the exception of spiny dogfish, USA/USSR catch ratios of various species groups for all 13 pair-tows combined, are all smaller (indicating greater fishing power differentials) than catch ratios for corresponding groups from the 1968 survey (1968 figures in parentheses in Table 2). The 1968 data in Table 2 represent the ratios of stratified mean catches (in pounds) for corresponding species groups in the entire area covered by the 1968 joint survey. Although the 13 pair-tows by themselves hardly constitute an adequate comparison of fishing power, the results are nevertheless consistent with expectations.

A more comprehensive measure of relative fishing power is provided by the comparison of catch per haul statistics for combined sets of sampling strata. Comparison of stratified mean (log) pounds per tow values for all species combined, show that the 24.6 trawl consistently made bigger catches than the #36 trawl throughout the entire survey area from Cape Hatteras to Georges Bank; and the differential was of the same order of magnitude as that observed for the 13 pair-tows (Table 3). Differentials varied with species, and as in previous years the fishing power of the larger trawl was relatively greater for red and silver hake than for other groundfish species such as cod, haddock, yellowtail and spiny dogfish (Table 3). Another similarity with past years was that in the southern area differentials were fairly consistent in small stratum sets and they tended to increase with level of abundance (Fig. 5). Comparison of fishing power factors (antilog of difference between stratified log means, USA-USSR) for selected species within the two main divisions of the survey area and among the three years, 1967-1969, demonstrates conclusively the greater fishing power of the 24.6 relative to the 27.1 as well as the #36 trawl (Table 4).

It should be recognized that estimates of fishing power factors based on ratios of stratified means for wide areas, are subject to larger sampling errors than estimates based on pair-tows or comparisons made within very restricted experimental areas such as in the 1967 gear comparisons reported by Hennemuth (1968). On the other hand, the factors based on many stratum sets do reflect a wider range of habitats and abundance levels, and in that sense provide a more complete picture of fishing power differentials. The tendency for size of differential to be related to level of abundance (size of mean) for individual species was apparent in the 1969 data as well as in previous years. While this may represent a real interaction between abundance and trawl efficiency it may also be partly due to the effects of positive skewness in catch frequencies even after transformation to the log scale.

Table 2. Total catch in pounds[1] by USA (*Albatross IV*, #36) and USSR (*Ekliptika*, 24.6 m trawl) vessels in 13 side-by-side hauls by species groups.

Species Group	Hauls 4,5		Hauls 1-3		Hauls 11-13		Hauls 6-10		13 Hauls combined			
	USA	USSR	USA	USSR	USA	USSR	USA	USSR	USA	USSR	USA/USSR	
Sharks	24	32	0	0	0	0	0	0	24	32	.75	
Spiny dogfish	0	18	23	206	0	t	2072	9848	2095	10,072	.21	(.21)[2]
Skates & Rays	66	191	t	9	16	30	14	199	96	429	.22	(.61)
Pelagic	8	11	53	61	1	6	18	552	80	630	.13	(.57)
Demersal	52	290	12	1111	31	150	189	3087	284	4638	.06	(.38)
Flounders	3	3	10	23	17	23	304	804	334	853	.39	(1.06)
Benthic Invertebrates	t	t	2	16	t	t	16	t	18	16	1.12	
Squid	30	23	634	2190	24	144	236	740	924	3097	.30	
Total	183	568	734	3616	89	353	2849	15,230	3855	19,767		
Ratio, USA/USSR	.32		.20		.25		.19		.20			(.39)

1/ Catches less than 1 pound indicated as t (trace).

2/ Ratios based on 1968 survey for comparable species groups - see text.

Table 3. Stratified mean catch in pounds ($\log_e$ scale) per 30-minute haul for selected species and all species combined in 1969 by stratum set and vessel (USA - *Albatross IV*; USSR - *Ekliptika*).

Stratum set	Spiny dogfish USA	Spiny dogfish USSR	Silver hake USA	Silver hake USSR	Red hake USA	Red hake USSR	Cod USA	Cod USSR	Haddock USA	Haddock USSR	Yellowtail USA	Yellowtail USSR	All species USA	All species USSR	All species USA/USSR
61-68 1/	0	0	0.006	0.076	0.020	0	0	0	0	0	0	0	4.511	6.459	0.14
69-72	0.440	0.627	0.113	0.978	0.304	0.580	0	0	0	0	0.763	0.524	3.873	5.942	0.13
73-76	2.447	3.720	0.355	1.388	0.296	1.109	0	0	0	0	1.640	2.300	4.605	6.030	0.24
1-4	3.415	3.782	0.766	1.879	0.636	1.964	0	0	0	0	2.366	2.197	4.764	7.078	0.10
5-8	4.000	4.486	1.553	3.518	1.951	2.960	0.538	0.587	0.148	0	2.186	2.010	5.606	6.943	0.26
9-12	1.855	3.919	1.342	3.676	0.857	1.724	0.338	0.331	0	0.157	1.418	1.041	4.512	6.144	0.20
13-15	0.682	0.722	0.620	2.616	1.108	2.069	0.168	0	0	0.195	1.817	1.949	3.708	4.774	0.34
16-18	0.261	0.336	0.405	1.699	0.930	1.512	0.463	0.817	0.544	1.358	1.740	2.343	3.700	5.041	0.26
19-20	2.058	1.158	1.511	2.769	1.241	2.914	1.664	1.616	0.685	1.154	1.748	3.422	4.577	5.770	0.30
21-25 2/	0.917	1.724	1.047	3.904	0.317	1.033	2.442	3.474	2.552	3.496	0.460	0.453	4.838	6.565	0.18
61-76, 1-12															
Mean	2.056	2.961	0.719	2.086	0.727	1.516	0.153	0.171	0.025	0.030	1.404	1.415	4.671	6.478	
Variance	0.024	0.067	0.005	0.024	0.009	0.029	0.004	0.008	0.001	0.001	0.019	0.036	0.024	0.015	
Fishing power factor 3/	.40		.25		.46		---		---		.99		.16		.16
13-25															
Mean	0.990	1.039	0.920	2.824	0.848	1.836	1.316	1.631	1.099	1.694	1.353	1.958	4.273	5.618	
Variance	0.018	0.048	0.015	0.051	0.015	0.075	0.025	0.019	0.022	0.068	0.025	0.065	0.022	0.018	
Fishing power factor 3/	.95		.15		.37		.73		.55		.55		.26		.26

1/ EKLIPTIKA made hauls only in three strata of this set: 65 (5 hauls), 66 (2 hauls), 67 (1 haul).
2/ EKLIPTIKA made no hauls in stratum 25.
3/ Fishing power factor is the antilog of the difference between log means, USA - USSR.

Table 4. Fishing power factors (see Table 3 for definition) for selected species and all species combined in 1967, 1968 and 1969, by stratum set.

Species	Strata 1-12, 61-76			Strata 13-25	
	1967	1968	1969	1968	1969
Spiny dogfish	.98	.64	.40	1.20	.95
Silver hake	.31	.30	.25	.70	.15
Red hake	.40	.67	.46	.84	.37
Yellowtail	1.32	1.34	.99	1.48	.55
Cod	-	.83	.98	.86	.73
Haddock	-	-	-	1.12	.55
All species	.62	.56	.16	.86	.26

Comparisons between the #36 and the 24.6 trawls were also made for the Browns-LaHave part of the Scotian Shelf, based on the independent coverage by the two vessels in the 1969 operations. However, of the individual species listed in Table 3, only cod and haddock were sufficiently abundant to provide meaningful comparisons with the areas west of Browns Bank. Stratified mean (log) pounds per tow for the four strata on the Scotian Shelf surveyed by *Albatros IV* (see Fig. 2), were compared with mean values for strata 31, 32, 41, 42, 45-48, covered by *Ekliptika* (Fig. 3, 4), and representing about the same area. The fishing power factors were .67 and .15 respectively for cod and haddock, and these values were lower (reflecting greater fishing power differential) than corresponding values of .73 and .55 for cod and haddock on Georges Bank (see Table 3). The factor for all species combined was .33 for the Browns-LaHave area, which was intermediate between the values for Georges Bank and the southern region.

Comparisons between the 24.6 and #36 trawls for the remainder of the Scotian Shelf survey by *Ekliptika*, were not made because there were so few cases where both trawls were fished in the same stratum. However, a quick appraisal of the data showed that the 24.6 trawl made very much larger catches than the #36; in fact, the #36 trawl catches were so small there is some question whether the gear was fishing at normal efficiency.

In summary, although analysis is not complete we have concluded that the 24.6 m trawl is unnecessarily large for a survey of groundfish. What advantages there may be in the still greater fishing power of the 24.6 as compared with the smaller trawls, seem to be far outweighed by the problems of handling such large catches.

Accuracy of Abundance Indices

In evaluating the groundfish survey from the standpoint of accuracy, the principal question is the size of difference in true abundance which we can detect with some known probability and cost. This obviously is a most difficult question in the absence of absolute abundance measures with which to compare catch per haul statistics. Nevertheless, indirectly we are gaining some insight into the accuracy of the survey method. We present here a brief evaluation of sampling errors associated with mean abundance indices from all three joint US-USSR surveys.

Approximate 95% confidence limits about stratified mean catch per haul statistics for red and silver hake, spiny dogfish, yellowtail and all species combined, are shown in Fig. 6 by year and major strata sets. The coefficients of variation of these compound means are on the order of 10%. However, these data illustrate the fact that even though there is a large differential in fishing power between two trawls, sampling errors associated with such means can mask the differential. For example, in the 1968 survey with the 27.1 and #36 trawls, there were significant differences between red and silver hake catches with the two trawls in the southern part of the area but not on Georges Bank (Fig. 6). Similarly differences in spiny dogfish means were significant only in the southern area for the 24.6 vs #36 trawl comparisons in 1969 (Fig. 6).

Another comparison of interest for a given pair of trawls is between years within the same area or vice versa. Abundance trends in the strata set (1-12, 61-76) from 1967 to 1968 appeared the same for dogfish, silver hake, yellowtail and all species combined, but not for red hake, where the US index increased and the USSR index decreased, with differences appearing significant within each year (Fig. 6). Comparing indices between strata sets in 1968 we see that both trawls showed apparent lower abundance of dogfish and red hake on Georges Bank, and about the same abundance of yellowtail in both areas; however, the USSR index of silver hake was significantly lower on Georges Bank whereas the US index was the same in both areas (Fig. 6). In 1969 the USSR silver hake index appeared significantly greater on Georges Bank than in the southern area, whereas the US silver hake index was only slightly greater (Fig.6).

Although these abundance indices are on the whole rather more consistent than inconsistent, there are enough discrepancies to indicate that blind acceptance of statistical confidence limits can lead to erroneous conclusions. These discrepancies may arise from factors such as variability in performance of trawls from haul-to-haul as well as the variability in fish distribution. In any case closer study of data by individual sampling strata and future monitoring of trawl performance on routine surveys should help clarify the situation.

Distribution of principal species

We present here only a few observations on fall distribution of selected groundfish species in relation to general patterns of bottom temperature. So far this aspect of the joint surveys has received little attention.

The general impression of biologists taking part in the fall surveys of the past three years is that no major changes occurred in fish distribution throughout the area from Cape Hatteras to Georges Bank. With the exception of spiny dogfish, this is confirmed by *Albatross IV* catch-per-haul statistics for several principal groundfish species, which show a relatively stable distribution pattern of abundance in October, 1967-1969; the only marked difference was that the abundance centre of spiny dogfish was further south in 1967 than in 1968 and 1969 (Fig. 7). It should be noted that the same shift was observed for both US and USSR indices (Lux, *et al*, 1969). This consistency within small stratum sets indicates that the level of accuracy of abundance indices is at least sufficient for detecting major shifts in fish distribution.

Bottom temperature patterns were very similar in October, 1967 and 1968, and in those years the cold cell of bottom water characteristically offshore in the mid-Atlantic Bight region (southeast of Long Island) until late autumn, was still pronounced. However, in October 1969 this cold cell was already partly dispersed (see Fig. 8), and offshore bottom temperatures were about 2°C warmer than in 1967 and 1968.

Turning now to the Nova Scotian shelf, it is possible to show only a very general abundance pattern from the 1969 data. Recall that *Ekliptika* used different trawls in an irregular pattern on the Scotian Shelf. Consequently, there is no good basis for estimating fishing power differentials among the trawls (and riggings) used. Nevertheless, simple mean catch (pounds) per haul statistics were computed for selected species by individual sampling strata (Table 5, Fig. 9, 10). Although no allowance was made for trawl type, (see Fig. 4 for stations by trawl type), these means provide an approximate picture of high and low areas of relative abundance for the principal species (Fig. 9, 10).

The general pattern of bottom temperature on the Scotian Shelf is shown in Fig. 11 (courtesy of Dr R.G. Halliday). These temperatures were obtained by *Ekliptika* over the period 15 November to 10 December. Because of the complex hydrography of the Scotian Shelf, these data provide only a generalized view of bottom temperature distribution.

Table 5. Mean catch in pounds[1] per 30-minute haul for selected species and all species combined by individual sampling strata. Survey of Nova Scotian Shelf in 1969 by USSR vessel *Ekliptika*.

ICNAF Subdivision	Stratum	Number hauls	Cod	Haddock	Yellowtail	Plaice	Silver hake	Sea herring	Argentine	Mackerel	Redfish	All species
	31	4	23	208	t	8	t	3		62	2	318
	32	4	48	496	2	3		2		t	1	750
	41	2	12	80		1	5	t			1	122
	42	2	8	392				2				404
	43	2		2		1	58	2			19	112
4X	44	3				t	1				2	[illegible]
	45	2	54	250		2						316
	46	3	30	103	2	13	t				t	184
	47	4	9	32		2	8	2		27		90
	48	4	8	20		3	2	t			t	41
	49	4		1		2	26		12		1	55
Total hauls		34										
	50	2		8		4	1	t	t		9	24
	51	3				t	3		t		4	9
	52	3			t	1	2				t	11
	53	5	2	5		2	t	t			t	9
	54	2		2	3	2					1	6
	55	4	59	334	28	4		1		t		480
4W	56	4	1			t	1		1		9	23
	59	3	42	78	2	33	4	2			8	208
	60	2	168	44	16	8	t	1		t		264
	62	3	3		50	6	t	t			t	110
	63	4	4	4	82	2	3					124
	64	3	2	13	5	38	1	3				108
	65	3			t	t	6		1		34	46
Total hauls		41										
	61	3			3	5		t			1	9
	66	4			2	14					t	25
4V	67	4		t	6	2						38
	68	3			3	14					t	55
	69	2							4		70	74
	70	2					1				72	78
Total hauls		18										

[1] t represents catch less than 1/2 pound; in figures 9 and 10, T.

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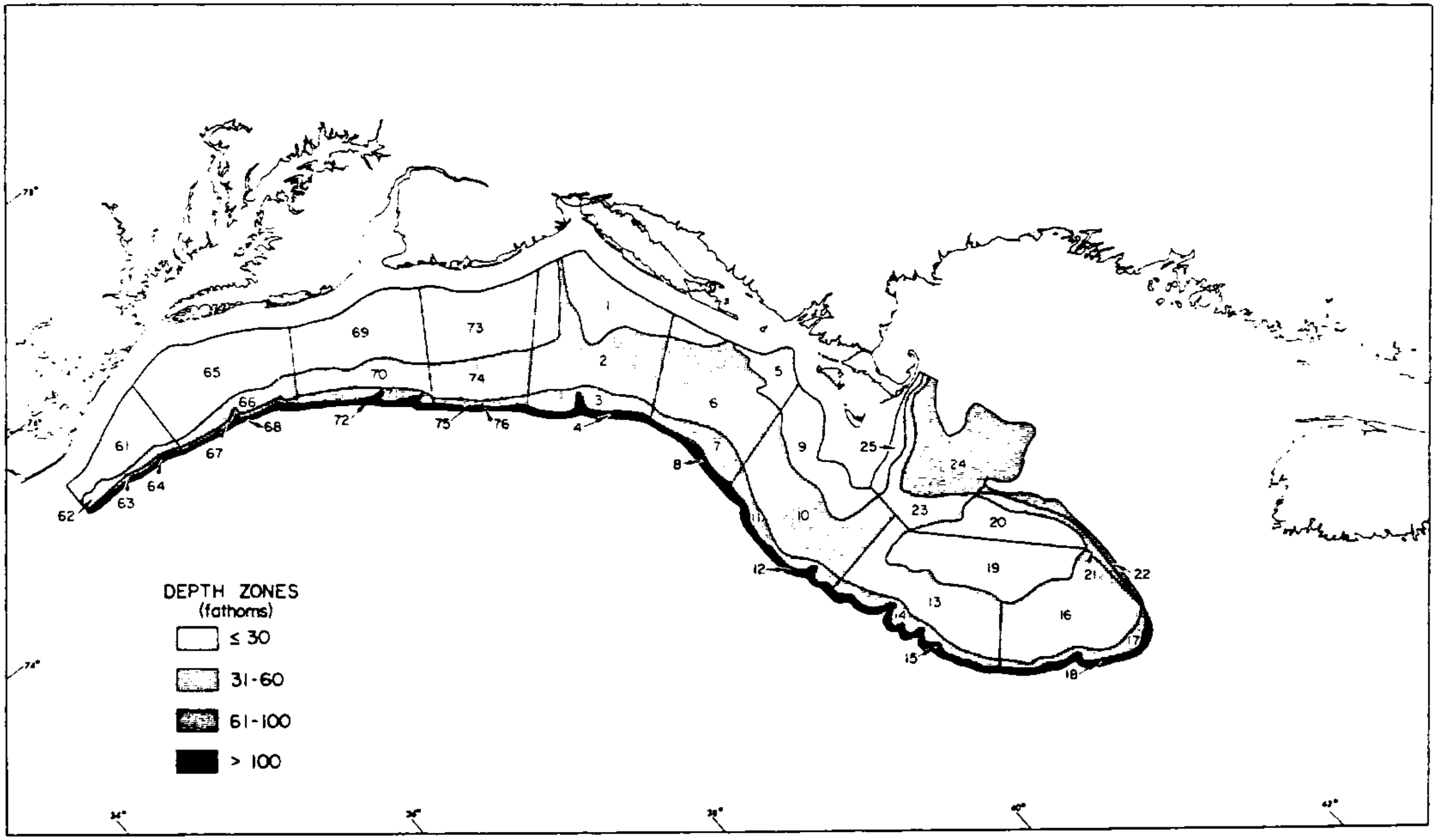

Fig. 1. Sampling strata covered simultaneously by the US and USSR vessels in the 1969 joint groundfish survey.

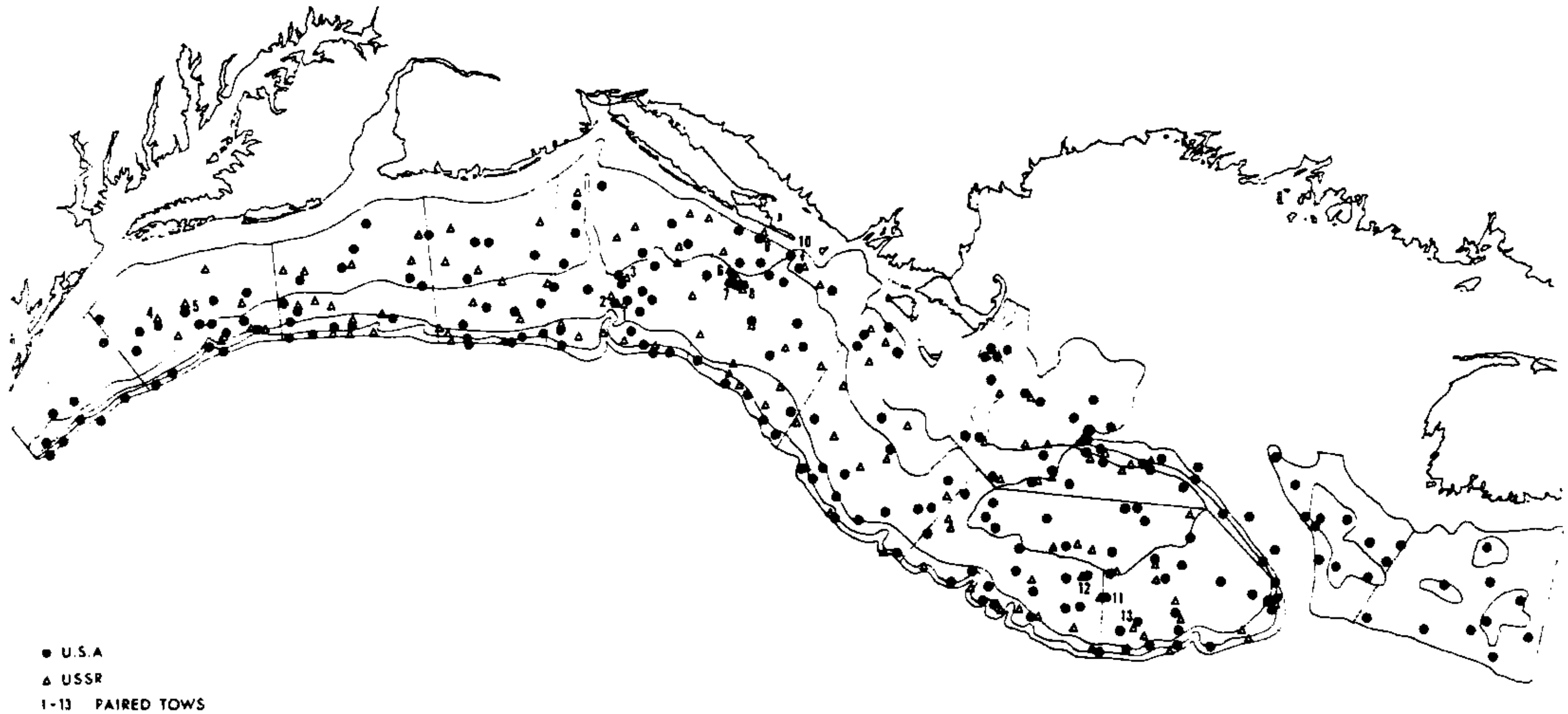

Fig. 2. Otter trawl stations occupied during the USA-USSR groundfish survey in 1969. Strata and stations off western Nova Scotia were surveyed independently by *Albatross IV*.

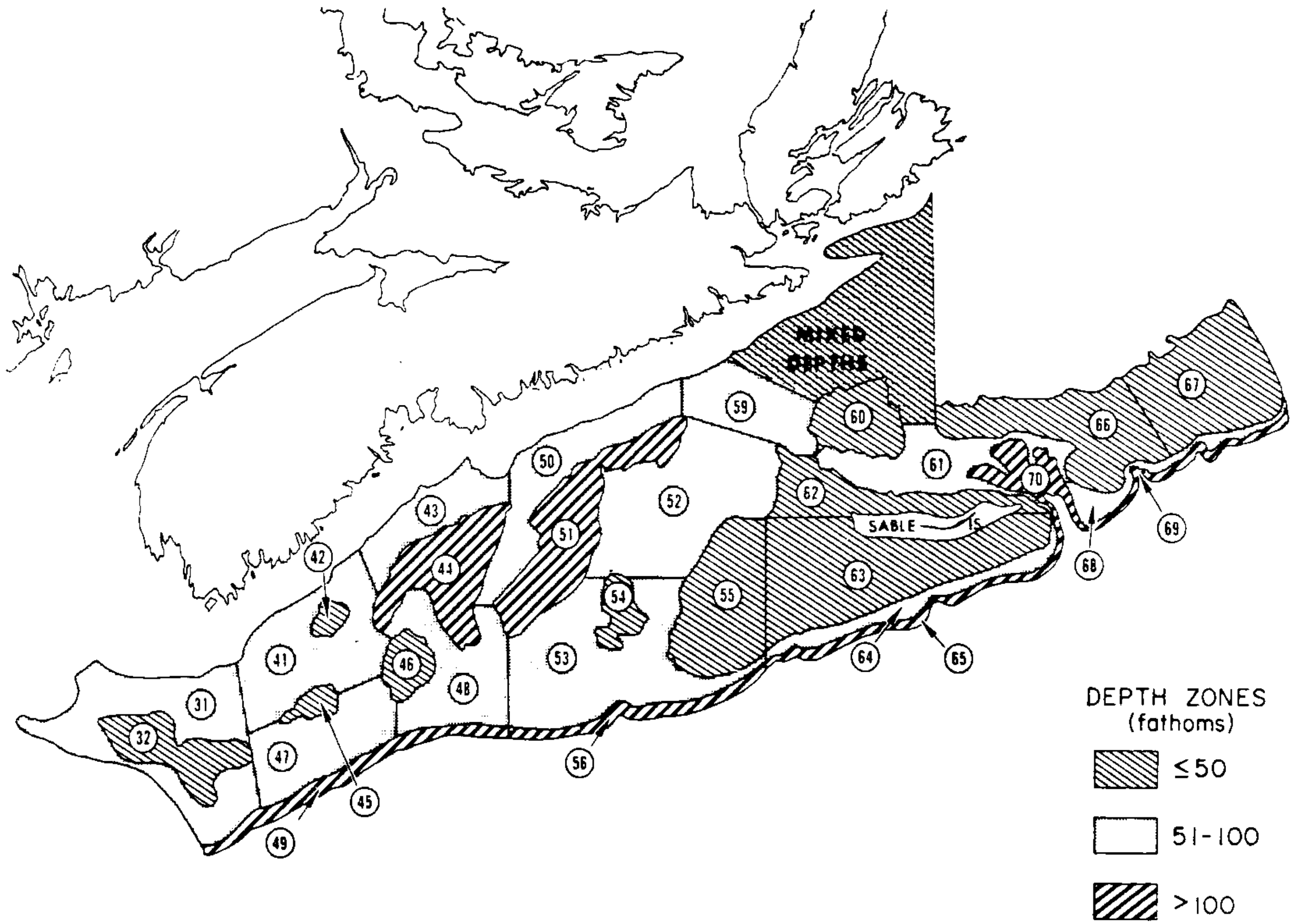

Fig. 3. Sampling strata used in the 1969 survey of the Nova Scotian Shelf by the USSR vessel *Ekliptika*.

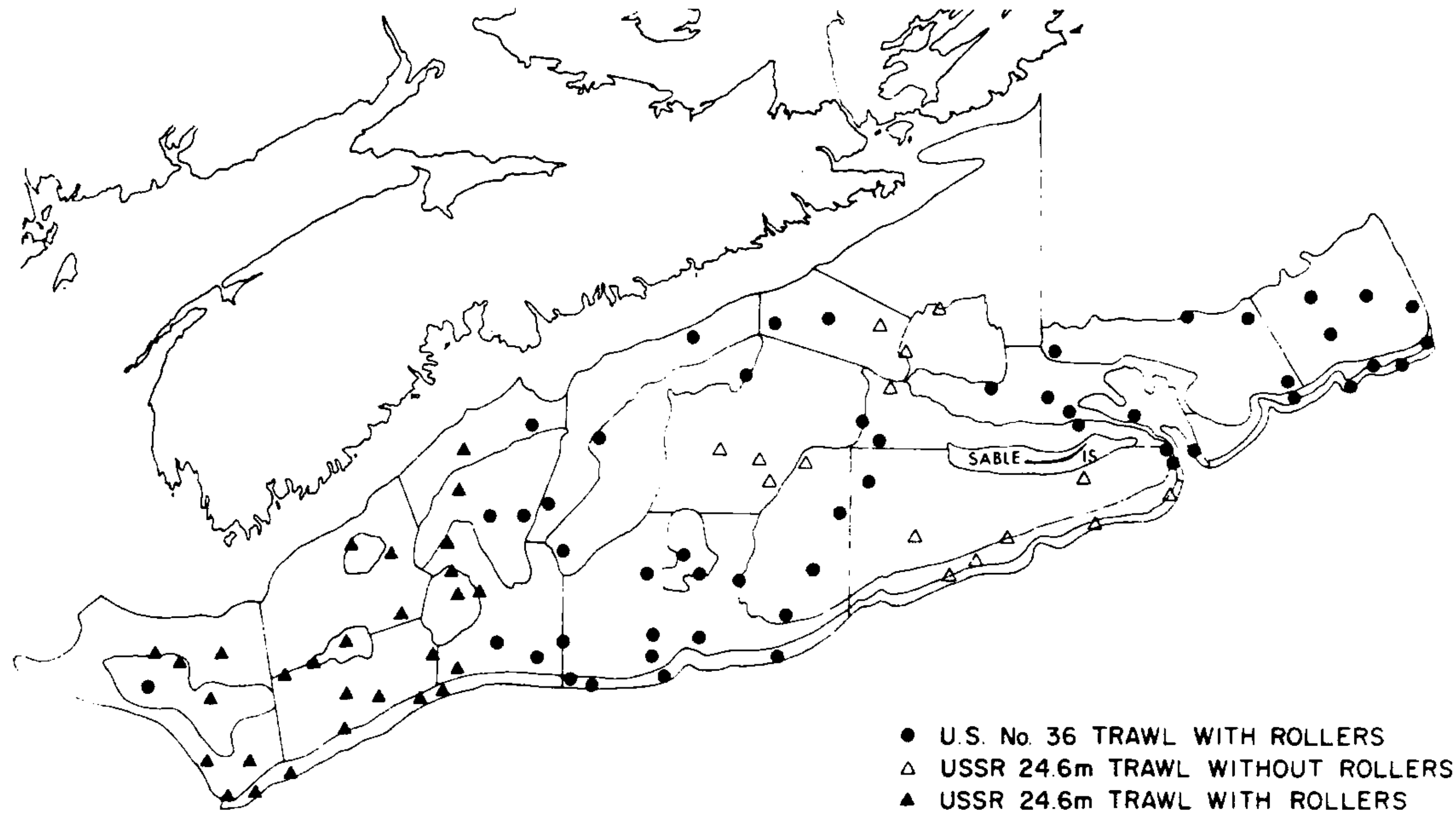

Fig. 4. Otter trawl stations occupied by USSR vessel *Ekliptika* during 1969 joint US-USSR groundfish survey

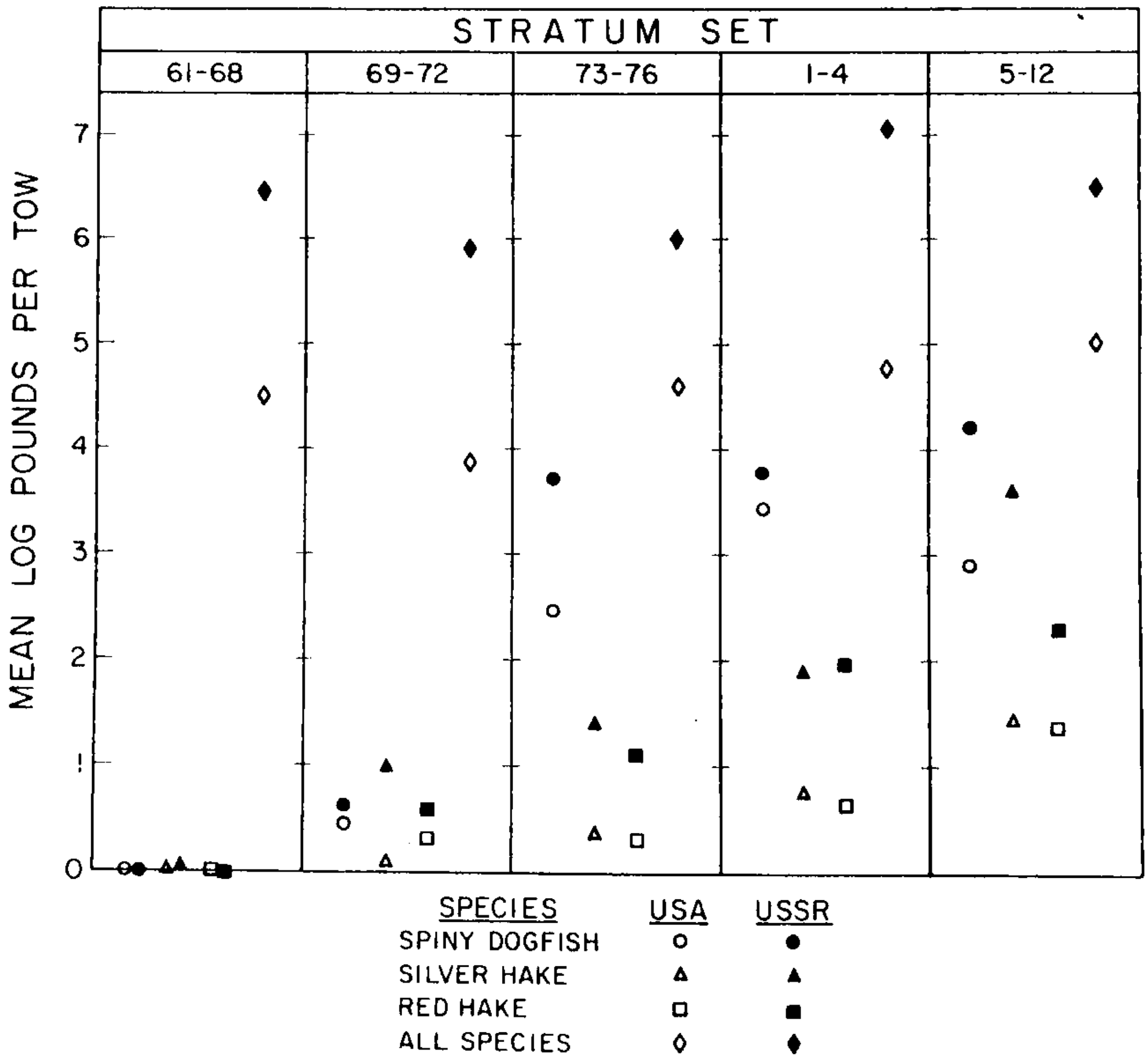

Fig. 5. Stratified mean catch in pounds ($\log_e$ scale) of selected species, and all species combined, for five stratum sets covering the area from Cape Hatteras to Nantucket shoals, in the 1969 joint US-USSR survey.

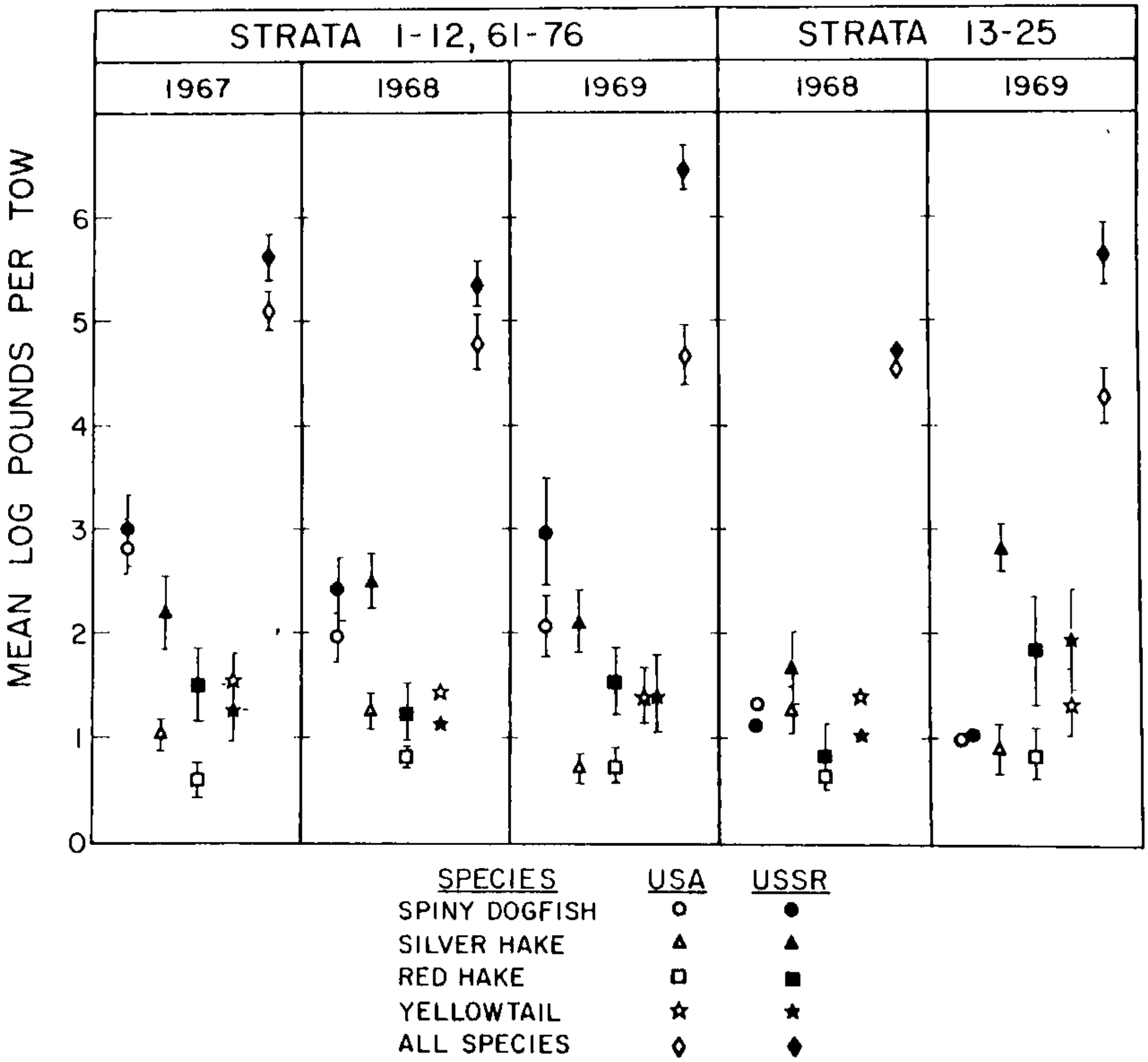

Fig. 6. Stratified mean catch per haul statistics for selected species by major strata sets in joint US-USSR surveys, 1967-1969. Strata 1-12, 61-76 (Cape Hatteras to Nantucket Shoals), Strata 13-25 (Georges Bank). Approximate 95% confidence limits shown as vertical lines.

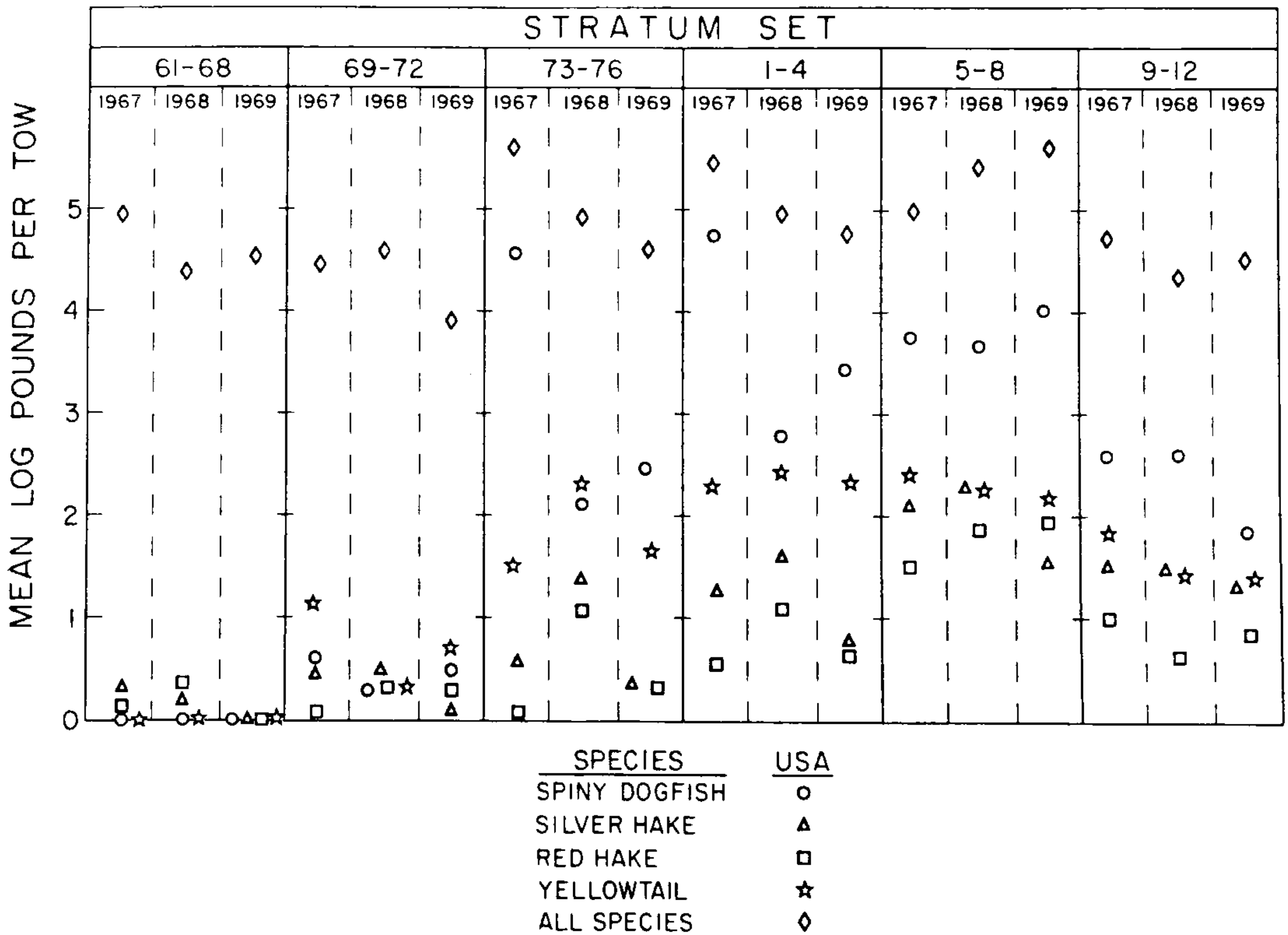

Fig. 7. Stratified mean log catch (pounds) per 30-minute haul of selected species by USA vessel *Albatross IV* during joint US-USSR surveys of the area from Cape Hatteras to Nantucket Shoals, 1967-1969.

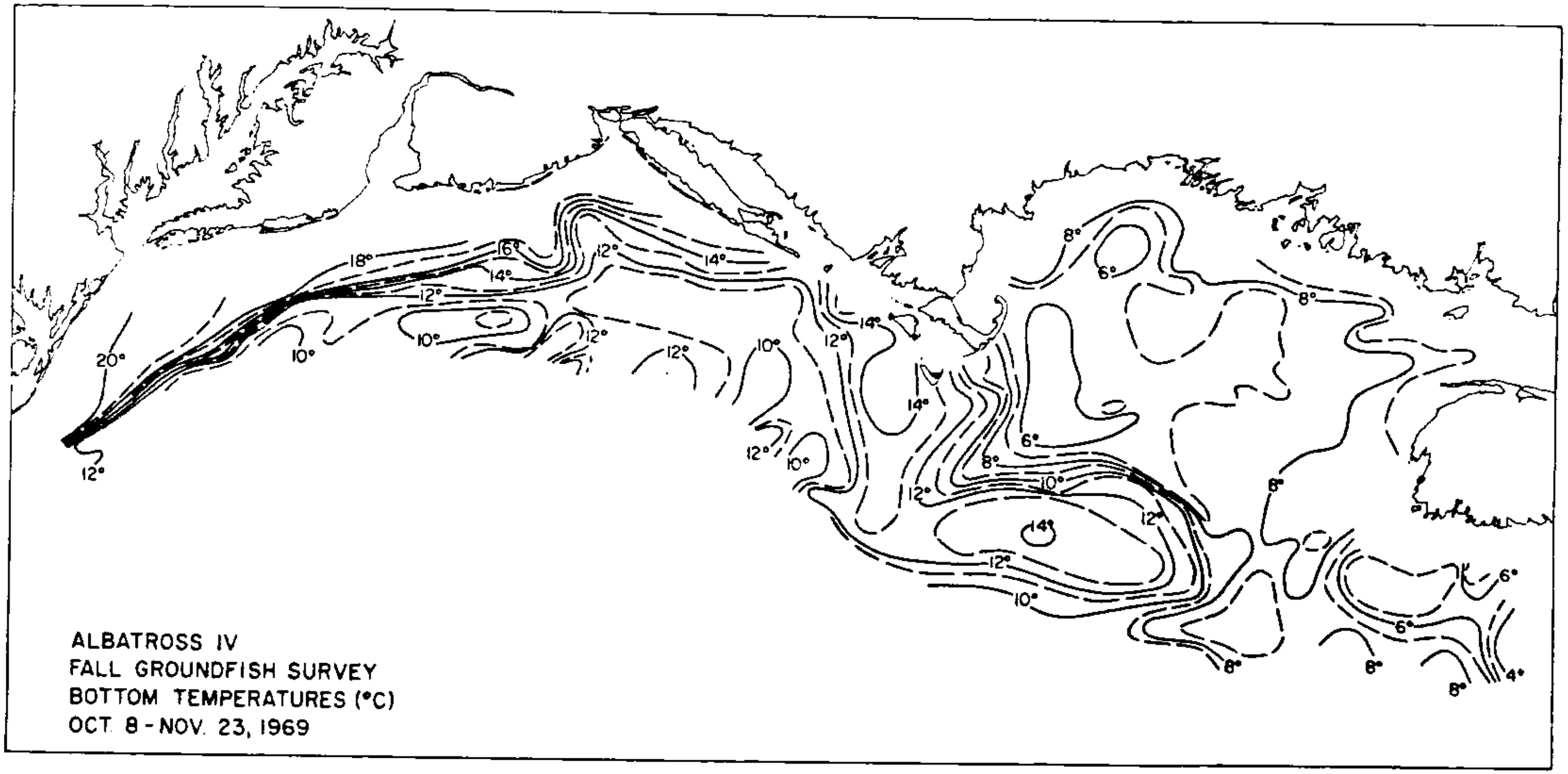

Fig 8. Bottom temperature pattern during *Albatross IV* groundfish survey in autumn, 1969.

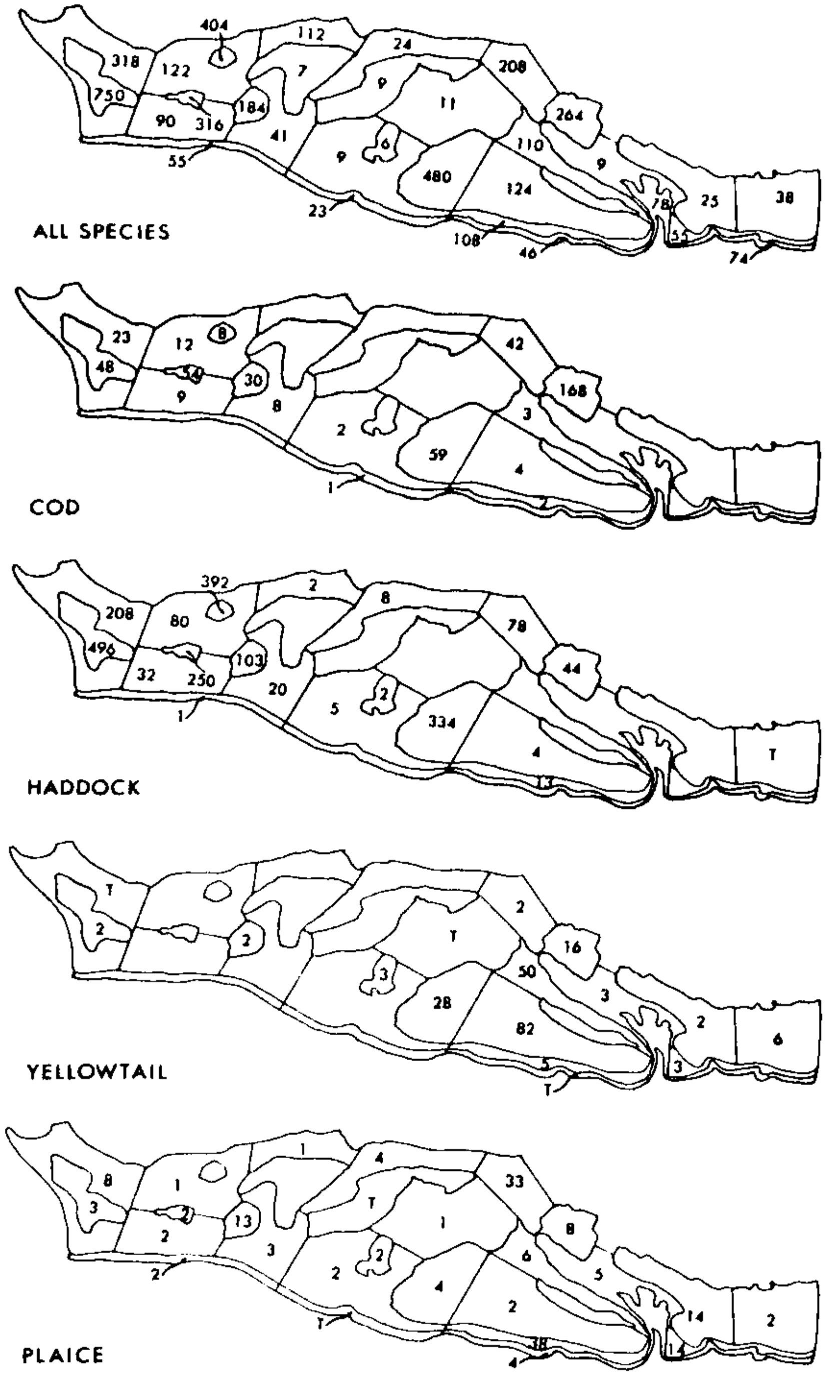

Fig. 9. Mean catch (pounds) per 30-minute haul of selected species and all species combined, by individual sampling strata. Survey by USSR vessel *Ekliptika* in November-December 1969. Catches of different trawl types combined in each stratum.

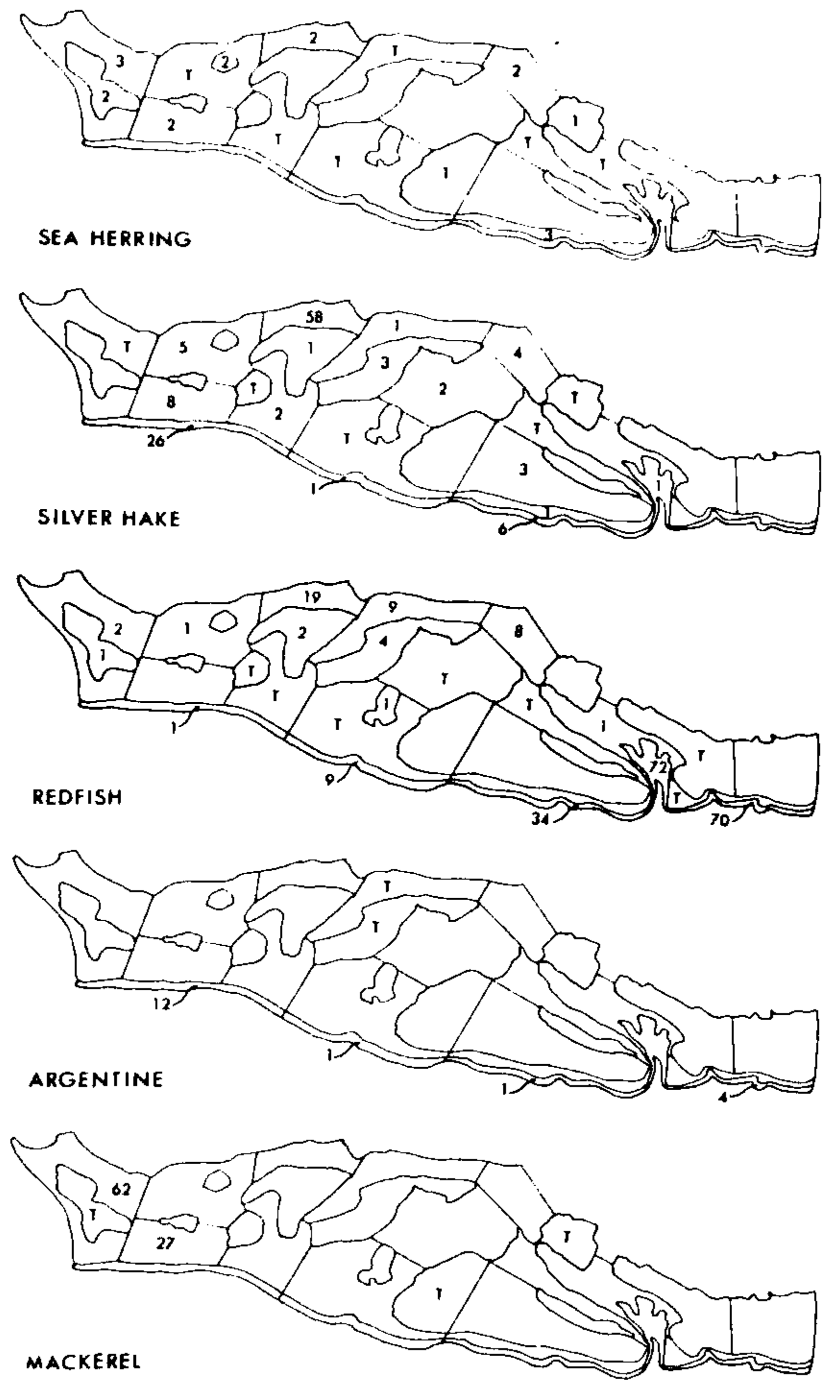

Fig. 10. Mean catch (pounds) per 30-minute haul of selected species by individual sampling strata. Survey by USSR vessel *Ekliptika* in November-December 1969. Catches of different trawl types combined in each stratum.

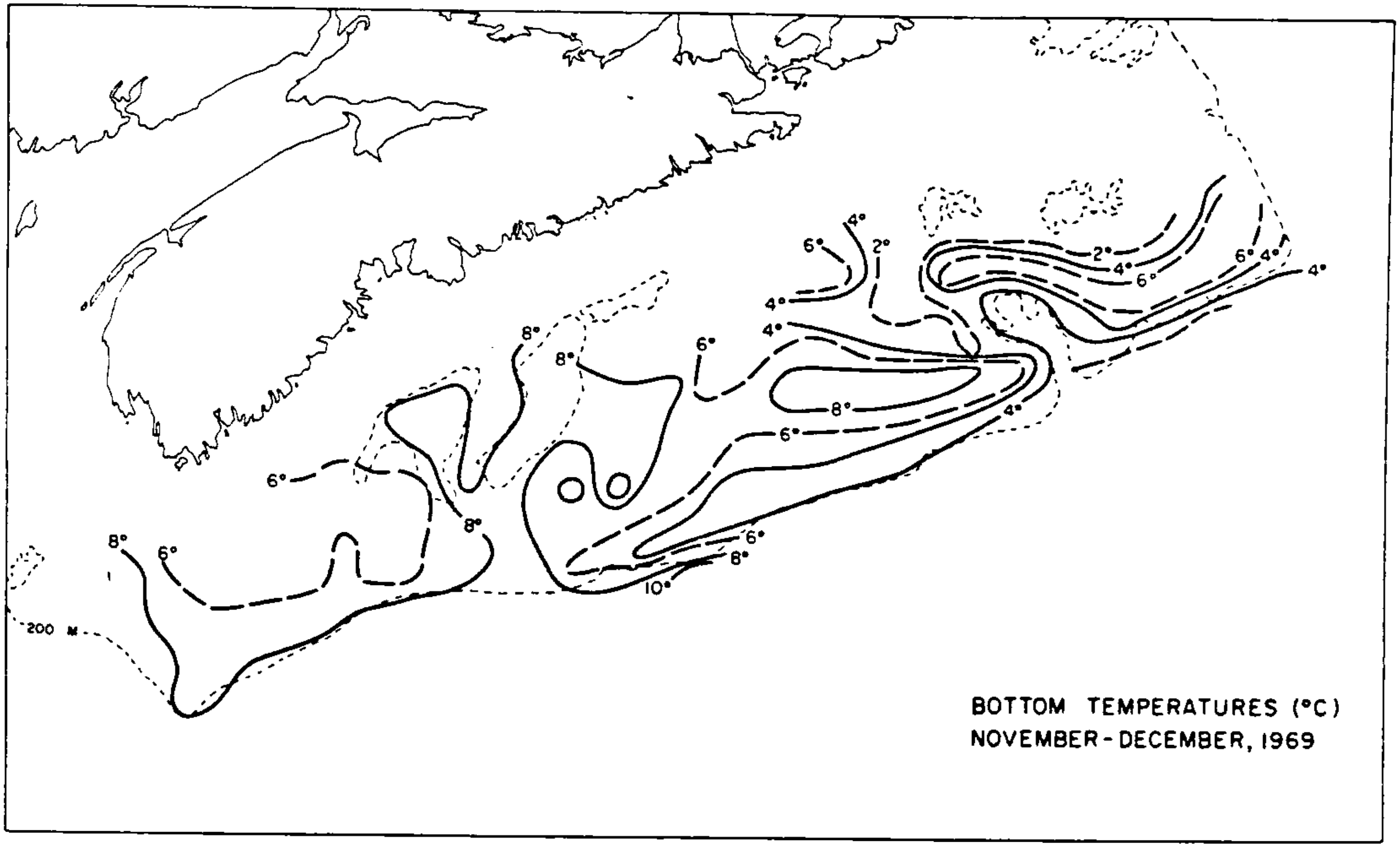

Fig. 11. Generalized bottom temperature pattern on Nova Scotian Shelf, November-December 1969, based on data from USSR vessel *Ekliptika*.

SECTION I
STATISTICS

19. Summary of Statistics on Discards, 1968[1]

by B.J. Kowalewski
ICNAF Secretariat

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

> "that the discard portion of the summary document on discards and industrial fish continued to be published annually in Redbook, Pt.III...." (Redbook 1969, Pt. 1, p.48).

Statistics on species and quantities of whole fish discarded at sea (discards) in 1968 by Canada (M), Canada (N), France (M), Germany (FRG), Poland, Portugal, Spain, UK and USA, and submitted on ICNAF Stat. Form 4, are summarized in the attached table.

Denmark (G) submitted a NIL return. Denmark (F), Iceland and Norway did not report their data. Italy did not fish in the Convention Area in 1968. In addition to its tabulated submissions Canada (M) wrote, "It remains normal practice to discard 100% of all silver hake, argentines, sculpins, lumpfish, sea robins, eelpouts and dogfish. Skates are landed occasionally but are normally discarded 100%. Some attempts were made to land and market anglers but this met with little success and most would be discarded. Discards by longliners and gill netters of commercial species of groundfish is negligible. Discards of pollock, hake and cusk by otter trawlers are also low."

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[1] submitted to the 1970 Annual Meeting of ICNAF as part of ICNAF Res.Doc. 70/25.

ABBREVIATIONS AND SYMBOLS USED
(as in latest Statistical Bulletin)

Species:	Gre	- Greenland halibut
	Had	- haddock
	Red	- redfish
	Sil	- silver hake
	Flo	- flounders
	Pla or (p)	- American plaice
	Wit or (w)	- witch
	Yel or (y)	- yellowtail flounder
	Gro	- groundfish
	Pol	- pollock
	Her	- herring
	Sha	- sharks
	Ska	- skates
	Sme	- smelt
	Shr	- shrimp
	Mix	- mixed
	NK	- not known
Gear:	OT	- otter trawl
	OT.Si	- otter trawl, side
	OT.St	- otter trawl, stern
	PT	- pair trawl
	DS	- Danish seine
	SS	- Scottish seine
Tonnage Class:	1	0 - 50 GRT
	1b	26 - 50 GRT
	2	51 - 150 GRT
	3	151 - 500 GRT
	4	501 - 900 GRT
	5	901 - 1800 GRT
	6	over 1800 GRT
Country:	Can (M)	- Canada (Maritime and Quebec)
	Can (N)	- Canada (Newfoundland)
	Fr (M)	- France (Metropolitan)
	Fr (SP)	- France (St. Pierre et Miquelon)
	Ger	- Germany
	Pol	- Poland
	Por	- Portugal
	Spa	- Spain

Source of information:

	Log	- logbook
	Int	- dockside interview
	Rep	- reports by captain
Symbols:	...	- not available or not reported
	-	- magnitude known to be nil or zero
	0	- magnitude known to be more than zero but less than half the unit

SUMMARY OF STATISTICS ON DISCARDS, 1968

Division	Main Species Sought	Gear and Tonnage Class	Country	COD Discard in tons	COD Nominal Catch in Tons	COD Rate of Discard (%)	HADDOCK Discard in Tons	HADDOCK Nominal Catch in Tons	HADDOCK Rate of Discard (%)	REDFISH Discard in Tons	REDFISH Nominal Catch in Tons	REDFISH Rate of Discard (%)	FLOUNDERS Discard in Tons	FLOUNDERS Nominal Catch in Tons	FLOUNDERS Rate of Discard (%)	MIXED Discard in Tons	MIXED Principal Species	MIXED Nominal Catch in Tons	MIXED Rate of Discard (%)	Source of Information	Sampling Rate in %
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1B	Cod	OT.Si 5	Fr(M)	1	999	0														Rep	100
	Cod	OT 4-6	Ger	1	75	1														Rep	100
	Cod	PT 3	Spa	180	8433	2										102	NK	-	100	Log	80
1C	Cod	OT.Si 6	Fr(M)	49	1164	4														Rep	100
	Cod	OT.St 6	Fr(M)	6	6284	0														Rep	100
	Cod	OT.Si 5	Fr(M)	291	17687	2				21	-	100	1	-	100					Rep	100
	Cod	OT.St 5	Fr(M)	4	1401	0							0	-	100					Rep	100
	Cod	OT.4-6	Ger	470	32550	1				15	1219	1				78	NK	108	42	Rep	100
	Cod	PT 3	Spa	0	2824	0										20	NK	-	100	Log	80
1D	Cod	OT.Si 6	Fr(M)	9	423	2														Rep	100
	Cod	OT.St 6	Fr(M)	4	890	0														Rep	100
	Cod	OT.Si 5	Fr(M)	102	9202	1				27	-	100	0	-	100					Rep	100
	Cod	OT.St 5	Fr(M)							2	-	100								Rep	100
	Cod	OT 4-6	Ger	649	45044	1				36	1999	2				105	NK	111	49	Rep	100
	Cod	OT.Si 4	UK													56	Cod	1079	5	Int	100
	Cod	PT 3	Spa	4	9276	0	1	-	100							64	NK	-	100	Log	80
1E	Cod	OT.Si 6	Fr(M)	14	495	3														Rep	100
	Cod	OT.St 6	Fr(M)	1	1683	0														Rep	100
	Cod	OT.Si 5	Fr(M)	22	5358	0				25	-	100	1	-	100					Rep	100
	Cod	OT 4-6	Ger	0	40370	0				36	1945	2				54	NK	1230	4	Rep	100
	Cod	OT.St 6	Por	84	6416	1										18	NK	-	100	Log	100
	Cod	OT.Si 4	UK													62	Cod	261	19	Int	100
	Cod	PT 3	Spa													7	NK	-	100	Log	80
1F	Cod	OT 4-6	Ger	26	15180	0				30	3619	1				56	NK	199	22	Rep	100
	Cod	OT.Si 4	UK													32	Cod	489	6	Int	100
Subarea 1				1917	205754	1	1	-	100	192	8782	2	2	-	100	654		3477	16		
Total catches					381869			34			9606			1772							

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
2H	Cod	OT 4-6	Ger	28	6092	0				2	-	100				5	NK	106	5	Rep	100
	Cod	OT,St 6	Por	66	8600	1										42	NK	-	100	Log	100
2J	Cod	OT.Si 6	Fr(M)	27	462	6														Rep	100
	Cod	OT.St 6	Fr(M)	10	12278	0				0	8	1								Rep	100
	Cod	OT.Si 5	Fr(M)	982	21548	4				92	-	100	0	-	100					Rep	100
	Cod	OT.St 5	(Fr(M)	2	4299	0				3	0	87	0	-	100					Rep	100
	Cod	OT 4-6	Ger	362	47868	1				22	354	6				20	NK	501	4	Rep	100
	Cod	OT.St 6	Por	210	10319	2										66	NK	-	100	Log	100
	Cod	OT.Si 5	Por	829	41166	2										275	NK	-	100	Log	100
	Cod	OT 5	Spa	99	32574	0										871	NK	-	100	Log	74
	Cod	PT 3	Spa													3	NK	-	100	Log	80
Subarea 2				2615	185206	1				119	362	25	0	-	100	1284		607	68		
Total catches					449342			4			8778			4953							
3K	Cod	OT 4	Can(N)	0	1481	0				0	32	0	0	189	0					Log	0
	Cod	OT,Si 6	Fr(M)	32	783	4														Rep	100
	Cod	OT.St 6	Fr(M)							0	6	5								Rep	100
	Cod	OT.Si 5	Fr(M)	611	20527	3				288	-	100	1	-	100					Rep	100
	Cod	OT.St 5	Fr(M)	1	1243	0				1	4	20								Rep	100
	Cod	OT.St 6	Por	60	659	8														Log	100
	Cod	OT.Si 5	Por	170	11853	1										228	NK	-	100	Log	100
	Cod	OT 5	Spa	39	13355	0										485	NK	-	100	Log	74
	Cod	PT 3	Spa	70	465	15										29	NK	-	100	Log	80
3L	Cod	OT 4	Can(N)	0	38	0	0	3	0	0	-	100	35	35	50					Log	3
	Cod	OT 3	Can(N)	0	1120	0							0	433	0					Log	3
	Cod	OT.Si 6	Fr(M)	20	351	5														Rep	100
	Cod	OT.St 6	Fr(M)	0	4512	0				1	22	4								Rep	100
	Cod	OT.Si 5	Fr(M)	470	11925	4				186	-	100	1	-	100					Rep	100
	Cod	OT.St 5	Fr(M)	1	404	0														Rep	100
	Cod	OT.St 6	Por	72	10011	1										17	NK	-	100	Log	100
	Cod	OT.Si 5	Por	795	50610	1										883	NK	-	100	Log	100
	Cod	OT 5	Spa	129	45608	0										2070	NK	-	100	Log	74
	Cod	PT 3	Spa	442	38692	1	26	950	3							856	NK	-	100	Log	80
	Plo	OT 3	Can(M)										297	3854	8					Log	4
	Pla	OT 4	Can(N)	309	18	98				0	-	100	1131	19	99					Log	5
	Pla	OT 3	Can(N)	0	985	0							199	4126	5					Log	7
	Wit	OT 4	Can(N)	0	28	...				0	0	...	0	11	0					Log	100
	Wit	OT 3	Can(N)	7	33	18							5	55	83					Log	100
	Yel	OT 4	Can(N)	0	372	0							20	141	12					Log	8

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
3L (cont'd)	Gre	OT 3	Can(N)	0	24	...							0	87	0					Log	82
3M	Cod	OT.Si 6	Fr(M)	2	33	1														Rep	100
	Cod	OT.Si 5	Fr(M)	96	12006	1				235	-	100	12	-	100					Rep	100
	Cod	OT.Si 5	Por	55	9989	1										88	NK	-	100	Log	100
	Cod	OT 5	Spa	3	4041	0										259	NK	-	100	Log	74
3N	Cod	OT.Si 5	Fr(M)	2	45	4				1	-	100								Rep	100
	Cod	OT 5	Spa	5	518	5										18	NK	-	100	Log	74
	Cod	PT 3	Spa	176	35640	0	43	382	10							747	NK	-	100	Log	80
	Pla	OT 4	Can(N)	0	1329	0				0	117	0	0	7072	0					Log	98
3O	Cod	OT 4	Can(N)	0	310	0							0	80	0					Log	8
	Cod	OT 5	Spa	0	59	1										2	NK	-	100	Log	74
	Cod	PT 3	Spa	106	33535	0	8	1168	1							856		-	100	Log	80
	Pla	OT 4	Can(N)							0	14	...	0	417	0					Log	1
	Wit	OT 4	Can(N)	0	79	0				0	24	...	0	1308	0					Log	5
3Pn	Cod	OT 4	Can(N)	0	106	0				0	8	...	0	6	...					Log	44
	Cod	OT 3	Can(N)	0	328	0	0	2	...	0	62	...	0	27	...					Log	24
	Cod	OT.Si 6	Fr(M)	30	648	5														Rep	100
	Cod	OT.Si 5	Fr(M)	38	2411		0	0	...	40	-	100	2	-	100					Rep	100
	Cod	OT.Si 5	Por	19	647	3										14	NK	-	100	Log	100
	Cod	OT 5	Spa													32	NK	-	100	Log	74
	Cod	PT 3	Spa													8	NK	-	100	Log	80
	Red	OT 3	Can(N)	0	75	0	0	0	...	0	2297	0	0	38	...					Log	11
3Ps	Cod	OT 4	Can(N)	0	3284	0	0	336	0	0	69	0	0	698	0					Log	9
	Cod	OT 3	Can(N)	0	2108	0	0	116	0	0	192	0	0	260	0					Log	8
	Cod	OT.St 6	Fr(M)							1	-	100	0	-	100					Rep	100
	Cod	OT.Si 5	Fr(M)	13	845	2				74	-	100	1	-	100					Rep	100
	Cod	OT 5	Spa	0	629	0										10	NK	-	100	Log	74
	Cod	PT 3	Spa	108	26239	0	45	1090	4							443	NK	-	100	Log	80
	Red	OT 3	Can(N)	0	267	0	0	7	...	0	2764	0	0	93	0					Log	10
	Red	OT 2	Can(N)	0	14	...	0			8	164	5	0	20	...					Log	81
	Flo	OT 3	Can(M)										219	1541	12					Log	4
	Pla	OT 4	Can(N)	0	167	0				0	69	0	0	1445	0					Log	98
	Pla	OT 3	Can(N)	0	175	0	0	30	...				0	1723	0					Log	0
	Wit	OT 4	Can(N)	0	90	0	0	57	...				0	423	0					Log	5

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
3Ps (cont'd)	Wit	OT 3	Can(N)	0	12	...	0	9	...	0	4	...	0	59	...					Log	11
Subarea 3				3881	350726	1	122	4150	3	835	5848	13	1923	24160	7	7045		-	100		
Total catches					732813			6545			52817			149780							
4R	Cod	OT 3	Can(M)	433	2592	14														Log	0
	Cod	OT 2	Can(M)	8	314	3														Log	16
	Cod	OT 4	Can(N)	0	1914	0				0	177	0	0	179	0					Log	2
	Cod	OT 3	Can(N)	58	2846	2	0	26	...	12	214	5	6	142	4	2	Gre	1	33	Log	21
	Cod	OT.Si 6	Fr(M)	93	1818	5														Rep	100
	Cod	OT.St 6	Fr(M)	4	1850	0				9	-	100	0	-	100					Rep	100
	Cod	OT.Si 5	Fr(M)	473	18419	3	1	2	33	96	-	100	1	-	100	20	NK	-	100	Rep	100
	Cod	OT.St 6	Por	30	1972	2														Log	100
	Cod	OT.Si 5	Por	27	4933	1										21	NK	-	100	Log	100
	Cod	OT 5	Spa	1	2271	0										71	NK	-	100	Rep	74
	Cod	PT 3	Spa	1	508	0										31	NK	-	100	Log	80
	Red	OT 2	Can(M)							496	5839	8								Log	1
	Red	OT 3	Can(N)	0	392		0	0		0	15004	0	2	117	2					Log	17
	Red	OT 1-3	USA	12	-	100										14	Shr	-	100	Int	100
	Pla	OT 4	Can(N)	0	1	...				0	0	...	0	1	...					Log	100
	Wit	OT 3	Can(N)	0	9	...	0	0	...				3	24	11					Log	100
4S	Red	OT 2	Can(M)	32	779	4				529	20364	2	22	426	5					Log	0
	Red	OT 3	Can(N)	0	11	...				0	724	0	0	2	...					Log	15
	Red	OT 1-3	USA	8	-	100				27	5007	1								Int	67
	Flo/Cod	OT 1b	Can(M)	2	546	0	-	100					28	166	14					Log	2
4T	Cod	OT 3	Can(M)	248	3311	7							25	386	6					Log	10
	Cod	OT 3	Can(N)	0	1709	0	0	11	...	0	85	0	0	259	0					Log	3
	Cod	PT 3	Spa													0		-	100	Log	80
	Cod/Flo	OT 2	Can(M)	1051	5713	16							913	4535	17					Log	13
	Cod/Flo	DS 1b	Can(M)	92	874	10							359	1616	18					Log	8
	Flo/Cod	OT 1b	Can(M)	747	7183	9							542	3553	15					Log	5
4Vn	Cod	OT 3	Can(M)	78	4402	2							65	476	12					Log	9
	Cod	OT 2	Can(M)	23	518	4														Log	12
	Cod	OT 3	Can(N)	68	1674	4	0	16	...	0	52	...	0	105	0					Log	15
	Cod	OT.Si 5	Fr(M)	3	139	2														Rep	100

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
4Vn	Cod	OT 5	Spa													26	NK	-	100	Log	74
(cont'd)	Cod	PT 3	Spa	5	2054	0										22	NK	-	100	Log	80
	Red	OT 3	Can(N)	0	31	...				0	1501	0	0	22	...					Log	21
	Flo	DS 2	Can(M)										795	889	47					Log	2
4Vs	Cod	OT 3	Can(M)	28	2212	1														Log	4
	Cod	OT.Si 5	Fr(M)	2	7	22				1	-	100	1	-	100					Rep	100
	Cod	OT 5	Spa	2	110	2										1	NK	-	100	Log	74
	Cod	PT 3	Spa	88	38035	0	57	1702	3							1059	NK	-	100	Log	80
	Red	OT 1-3	USA													7	Sme	-	100	Int	67
	Flo	OT 3	Can(M)										2628	7009	27					Log	3
	Pla	OT 3	Can(N)	0	111	0	0	0	...				0	305	0					Log	4
	Wit	OT 3	Can(N)	0	16	...	0	1	...							19	Pla	32	37	Log	16
4W	Cod	PT 3	Spa	190	12273	2	42	1458	3							283	NK	-	100	Log	80
	Cod/Flo	DS 1b	Can(M)										417	321	57					Log	0
4X	Cod	PT 3	Spa	6	2829	0	1	116	1							17	NK	-	100	Log	80
	Had	OT 2-3	USA				24	3015	1											Int	67
	Had/Cod	OT 3	Can(M)	43	7197	1	100	9973	1				279	519	35					Log	1
Subarea 4				3856	131573	3	225	16420	1	1170	48967	2	6086	21052	22	1593		33	98		
Total catches					247333			45991			104066			71840							
5Y	Red	OT 1-3	USA	7	13	35														Int	67
5Ze	Cod	PT 3	Spa	26	14488	0	87	2845	3							313	NK	-	100	Log	80
	Had/Cod	OT 3	Can(M)				96	3160	3											Log	0
	Had/Cod	OT 2	Can(M)	2	22	8														Log	17
	Had	OT 2-3	USA	83			64													Int	67
	Red	OT 1-3	USA	7																Int	67
	Yel	OT 1-3	USA										8760	20245	30					Int	20
	Her	OT 4	Pol	4	505	1	1	477	0				2	-	100	24	Sil	307	7	Int	33
5Zw	Cod	PT 3	Spa				4	169	2							1	NK	-	100	Log	80
	Her	OT 4	Pol	6	98	6	2	36	5				2	-	100	24	Sil	9	73	Int	33
5Z[a]	Her	OT 5-6	Ger													984	Her	62856	2	Rep	100
Subarea 5				135	15126	1	254	6687	4				8764	20245	30	1346		63172	2		
Total catches					49176			44477			6777			53432							
6A	Her	OT 4	Pol										3	-	100	15	Sil	5	75	Int	33
6B	Her	OT 4	Pol	2	-	100	2	-	100				3	-	100	14	Sil	-	100	Int	33
Subarea 6				2	-	100	2	-	100				6	-	100	29		5	85		
Total catches					381			49			-			8080							
Discards by Subareas																					
Subarea 1				1917	205754	1	1	-	100	192	8782	2	2	-	100	654		3477	16		
Subarea 2				2615	185206	1				119	362	25	0	-	100	1284		607	68		
Subarea 3				3881	350726	1	122	4150	3	835	5848	13	1923	24160	7	7045		-	100		
Subarea 4				3856	131573	3	225	16420	1	1170	48967	2	6086	21052	22	1593		33	98		
Subarea 5				135	15126	1	254	6687	4				8764	20245	30	1346		63172	2		
Subarea 6				2	-	100	2	-	100				6	-	100	29		5	85		
Statistical area				12406	888385	1	604	27257	2	2316	63959	4	16781	65457	20	11951		67294	15		
Total catches					1860914			97100			182044			289857							

SECTION J

TRAWL MATERIAL AND MESH SIZE SAMPLING

20. Summary of Trawl Material and Mesh Size Sampling Data, 1966-1968 [1]

by B.J. Kowalewski
ICNAF Secretariat

Introduction

At the 1966 Annual Meeting the Subcommittee on Gear and Selectivity

recommended

"that the 1964 and 1965 submission of trawl material and mesh size sampling data should be summarized by the Secretariat and included in Part II and III of the 1966 Redbook. Thereafter this information should be summarized and published in the Redbook every third year beginning with Redbook 1969." (Redbook 1966, Part I, p.65).

The Summary for 1964 and 1965 was published in Redbook 1966, Part III, p.191-200. The Summary for 1966-1968 is presented herewith.

Methods

(a) In fulfilling the 1966 recommendation, trawl material and mesh size sampling data are summarized and presented herewith by the Secretariat in Part A, B and C of this paper for the years 1966, 1967 and 1968 accordingly.

(b) The paper presents the number of codends with average mesh size greater than (>), equal to (=) and less than (<) in the 108-121 mm (4 1/2 - 4 3/4 inch) mesh size group.

(c) The type of mesh gauge used in measuring the meshes of codends sampled is presented after the name of reporting country.

(d) All data presented in Parts A, B and C are based on measurements of meshes of codends after use.

(e) The proportion of codends which were using topside chafing gear (ch) to those codends measured (ce) is presented for each gear, species or group of species and subarea

(f) Abbreviations for the net materials used for the codends are as follows:

PA - polyamides
PES - polyesters
PE - polyethylenes

1 Extracted from Res Doc. 67/23, 68/25 and 69/30

PP - polypropylenes
MS - manila or sisal
O - other materials

(g) Abbreviations for the species of fish as follows:

Had - haddock
Red - redfish
Sil - silver hake
Hak - hake (*Urophysis* spp)
Pol - pollock
Yel - Yellowtail flounder
Gre - Greenland halibut
Fla - flatfish
Her - herring
Mac - mackerel
Mix - mixed
Ind - industrial

(h) Abbreviations for the gear types are as follows:

OT.Si - Otter trawl, side
OT.St - Otter trawl, stern

Part A. Trawl Material and Mesh Size Sampling Summary for 1966

The Summary is based on data submitted by Canada, France, Germany, Fed.Rep., Poland, Portugal, USSR, UK and USA, and presented to the 1967 Annual Meeting of the Commission as Res. Doc. 67/23.

Canada - 1966
(ICNAF gauge)

Species	Gear	Mesh size group (110-114 mm)	No. of codends measured: Subarea 3 PA PES	Subarea 3 PE	Subarea 3 PP	Subarea 3 MS	Subarea 3 O	Subarea 4 PA PES	Subarea 4 PE	Subarea 4 PP	Subarea 4 MS	Subarea 4 O	Subarea 5 PA PES	Subarea 5 PE	Subarea 5 PP	Subarea 5 MS	Subarea 5 O
Cod	OT	>	-	3	4	1	-	21	21	13	-	-	-	3	5	-	-
	Si	=	16	4	8	-	-	26	9	12	-	-	2	-	-	-	-
		<	22	2	-	-	-	57	30	2	-	-	-	-	-	-	-
		ch/ce			58/60					88/191					6/10		
	OT	>	2	1	-	-	-	2	2	2	-	-	1	2	2	-	-
	St	=	7	-	-	-	-	4	-	1	-	-	-	-	-	-	-
		<	-	-	-	-	-	3	1	2	-	-	-	-	-	-	-
		ch/ce			6/10					4/17					0/5		
Had	OT	>	-	1	1	-	-	9	3	3	-	-	2	-	4	-	-
	Sis	=	1	-	-	-	-	17	10	5	-	-	3	-	3	-	-
		<	-	1	-	-	-	47	4	-	-	-	2	-	-	-	-
		ch/ce			4/4					32/98					14/14		
	OT	>	-	-	-	-	-	2	2	-	-	-	-	-	2	-	-
	St	=	-	-	-	-	-	-	1	4	-	-	-	-	1	-	-
		<	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
		ch/ce								0/9					0/4		
Red	OT	>	1	1	6	-	-	2	2	-	-	-	-	-	-	-	-
	Si	=	3	3	3	-	-	3	5	3	-	-	-	-	-	-	-
		<	5	2	2	-	-	60	21	1	-	-	-	-	-	-	-
		ch/ce			24/26					29/97							
	OT	>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	St	=	1	-	-	-	-	3	-	-	-	-	-	-	-	-	-
		<	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-
		ch/ce			1/1					1/7							
Pol	OT	>	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-
	Si	=	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
		<	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-
		ch/ce								3/8							
	OT	>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	St	=	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		<	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
		ch/ce													0/1		
Hak	OT	>	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-
	Si	=	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
		<	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		ch/ce								0/4							
Fla	OT	>	7	8	36	-	-	16	17	2	-	-	-	-	-	-	-
	Si	=	47	12	17	-	-	7	6	4	-	-	-	-	-	-	-
		<	94	8	6	1	-	18	7	-	-	-	-	-	-	-	-
		ch/ce			233/236					30/77							
	OT	>	5	-	-	-	-	1	-	-	-	-	-	-	-	-	-
	St	=	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		<	45	-	2	-	-	2	-	-	-	-	-	-	-	-	-
		ch/ce			19/63					1/3							
All Species	OT	>	8	14	47	1	-	51	44	19	-	-	2	3	9	-	-
	Si	=	67	19	28	-	-	54	30	25	-	-	5	-	3	-	-
		<	121	13	8	1	-	187	62	3	-	-	2	-	-	-	-
	Total		196	46	83	2	-	292	136	47	-	-	9	3	12	-	-
	Total	ch/ce			319/326					182/475					20/24		
	OT	>	7	-	-	-	-	5	4	2	-	-	1	2	4	-	-
	St	=	19	-	-	-	-	7	1	5	-	-	-	-	1	-	-
		<	45	-	2	-	-	9	1	2	-	-	-	-	2	-	-
	Total		71	-	2	-	-	21	6	9	-	-	1	2	7	-	-
	Total	ch/ce			26/74					6/36					0/10		

Note: Only ICNAF chafer used.

France - 1966
(NEAFC simple flat gauge)

Species	Gear	Mesh size group (110-114 mm)	No. of codends measured				
			Subarea 1,2,3,4				
			PA PES	PE	PP	MS	O
Cod	OT	>	105	-	-	-	-
	Si	=	7	-	-	-	-
		<	7	-	-	-	-
		ch/ce	0/119				

GERMANY, Fed.Rep. - 1966
(ICES gauge)

Species	Gear	Mesh size group (110-114 mm)	No. of codends measured				
			Subarea 1,2,3				
			PA PES	PE	PP	MS	O
Cod	OT	>	4	5	-	-	-
Had	Si	=	7	-	-	-	-
Red		<	14	3	-	-	-
		ch/ce	33/33				
	OT	>	5	3	-	-	-
	St	=	2	1	-	-	-
		<	7	-	-	-	-
		ch/ce	7/18				

Note: Chafers used similar in design to the ICNAF type, but sustantially narrower in width.

Poland - 1966
(ICNAF gauge)

Species	Gear	Mesh size group (110-114 mm)	No. of codends measured				
			Subarea 3				
			PA PES	PE	PP	MS	O
Cod	OT	>	45	-	-	-	-
Had	St	=	-	-	-	-	-
Red		<	19	-	-	-	-
Fla		ch/ce	0/64				

Portugal - 1966
(ICES simple flat gauge)

Species	Gear	Mesh size group (110-114 mm)	No. of codends measured: Subarea 1,2,3,4 PA PES	PE	PP	MS	O
Cod	OT	>	17	27	–	–	–
	Si[1]	=	20	99	–	–	–
		<	–	–	–	–	–
		ch/ce		45/163[3]			
	OT	>	–	–	–	–	–
	St[2]	=	6	8	–	–	–
		<	–	–	–	–	–
		ch/ce		6/14[4]			

1 New and used codends

2 New codends

3 ICNAF chafers

4 Other type chafers

USSR - 1966
(ICNAF gauge

Species	Gear	Mesh size group (110-114 mm)	Subarea 3 PA PES	PE	PP	MS	O	Subarea 5 PA PES	PE	PP	MS	O
Cod	OT	>	–	–	–	–	–	–	–	–	–	–
Red	Si	=	5	–	–	–	–	–	–	–	–	–
Fla	St	<	11	–	–	–	–	–	–	–	–	–
		ch/ce		7/16[1]								
Cod	OT	>	–	–	–	–	–	–	–	–	–	–
Had	St	=	–	–	–	–	–	24	–	–	–	–
Red		<	–	–	–	–	–	22	–	–	–	–
Fla		ch/ce							46/46[2]			

1 Other type chafers

2 ICNAF chafers

UK - 1966
(NEAFC - simple flat gauge)

Species	Gear	Mesh size group (110-114 mm)	Subarea 2 PA PES	PE	PP	MS	O	Subarea 3 PA PES	PE	PP	MS	O
Cod	OT[1]	>	–	–	1	–	–	–	–	3	–	–
Had		=	–	–	1	–	–	–	–	2	–	–
Fla		<	–	–	–	–	–	–	–	–	–	–
		ch/ce		0/2					0/5			

1 Not reported if side or stern trawls

USA - 1966
(ICES and ICNAF gauges)[1]

Species	Gear	Mesh size group (110-114 mm)	Subarea 4 PA PES	Subarea 4 PE	Subarea 4 PP	Subarea 4 MS	Subarea 4 O	Subarea 5 PA PES	Subarea 5 PE	Subarea 5 PP	Subarea 5 MS	Subarea 5 O	Subarea 3,4,5 PA PES	Subarea 3,4,5 PE	Subarea 3,4,5 PP	Subarea 3,4,5 MS	Subarea 3,4,5 O	Subarea 4,5 PA PES	Subarea 4,5 PE	Subarea 4,5 PP	Subarea 4,5 MS	Subarea 4,5 O
Cod	OT	>	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	3	-	-	-	-
Had	Si	=	2	-	-	-	-	20	1	-	-	-	-	-	-	-	-	39	-	-	1	-
		<	55	-	-	-	-	68	-	-	-	-	-	-	-	-	-	135	-	3	-	-
		ch/ce	12/57					12/91										12/181				
Red	OT	>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Si	=	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		<	-	-	-	-	-	-	-	-	-	-	35	-	-	-	-	-	-	-	-	-
		ch/ce											0/35									
Hak	OT	>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Si	=	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		<	-	-	-	-	-	40	-	14	-	-	-	-	-	-	-	-	-	-	-	-
		ch/ce						18/54														
Fla	OT	>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Si	=	-	-	-	-	-	33	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		<	-	-	-	-	-	104	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		ch/ce						17/137														
Mix	OT	>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Si	=	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		<	-	-	-	-	-	27	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		ch/ce						9/27														
Ind	OT	>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Si	=	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		<	-	-	-	-	-	8	3	-	-	-	-	-	-	-	-	-	-	-	-	-
		ch/ce						0/11														
All species	OT	>	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	3	-	-	-	-
	Si	=	2	-	-	-	-	53	1	-	-	-	-	-	-	-	-	39	-	-	1	-
		<	55	-	-	-	-	247	3	14	-	-	35	-	-	-	-	135	-	3	-	-
	Total		57	-	-	-	-	302	4	14	-	-	35	-	-	-	-	177	-	3	1	-
	Total	ch/ce	12/57					56/320					0/35					12/181				

Note:[1] ICES chafers used only
ICNAF gauge used only for Subarea 4 and 5 data (last column)

B. Trawl Material and Mesh Size Sampling Summary for 1967

The Summary is based on data submitted by Canada, France, Germany, Fed. Rep., Poland, Portugal, USSR, UK and USA, and presented to the 1968 Annual Meeting of the Commission as Res. Doc. 68/25.

Canada - 1967
(ICNAF gauge)

Species	Gear	Mesh size group (110-114 mm)	Subarea 3 PA PES	Subarea 3 PE	Subarea 3 PP	Subarea 3 MS	Subarea 3 O	Subarea 4 PA PES	Subarea 4 PE	Subarea 4 PP	Subarea 4 MS	Subarea 4 O	Subarea 5 PA PES	Subarea 5 PE	Subarea 5 PP	Subarea 5 MS	Subarea 5 O
			No. of codends measured														
Cod	OT	>	2	3	-	-	-	8	11	16	1	-	3	2	1	-	-
	Si	=	15	2	1	-	-	21	7	4	-	-	1	-	4	-	-
		<	20	1	1	-	-	8	2	3	-	-	-	-	-	-	-
		ch/ce			34/45					17/81					7/11		
	OT	>	4	1	-	-	-	4	3	3	-	-	-	-	-	-	-
	St	=	2	-	-	-	-	-	-	1	-	-	-	-	-	-	-
		<	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-
		ch/ce			0/7					1/14							
Had	OT	>	-	-	1	-	-	6	2	11	-	-	-	-	3	-	-
	Si	=	-	-	-	-	-	2	3	9	-	-	1	-	6	-	-
		<	3	-	-	-	-	3	1	-	-	-	-	1	-	-	-
		ch/ce			1/4					13/37					11/11		
	OT	>	-	-	-	-	-	-	1	4	-	-	-	1	-	-	-
	St	=	-	-	-	-	-	6	1	-	-	-	1	3	1	-	-
		<	-	-	-	-	-	15	2	-	-	-	-	-	-	-	-
		ch/ce								.../29					2/6		
Red	OT	>	-	-	3	-	-	3	1	-	-	-	-	-	-	-	-
	Si	=	2	-	1	-	-	3	-	-	-	-	-	-	-	-	-
		<	5	1	4	-	-	36	22	5	-	16[a]	-	-	-	-	-
		ch/ce			16/16					2/86							
	OT	>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	St	=	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		<	2	1	1	-	-	1	3	-	-	-	-	-	-	-	-
		ch/ce			2/4					1/4							
Fla	OT	>	7	9	11	-	-	17	6	5	-	-	-	-	-	-	-
	Si	=	23	20	3	-	-	6	8	1	-	-	-	-	-	-	-
		<	59	16	5	-	-	7	8	2	-	-	-	-	-	-	-
		ch/ce			137/153					6/60							
	OT	>	5	8	-	-	-	-	-	1	-	-	-	-	-	-	-
	St	=	5	5	1	-	-	-	-	-	-	-	-	-	-	-	-
		<	47	3	20	-	-	-	-	-	-	-	-	-	-	-	-
		ch/ce			55/194					1/1							
Pol	OT	>	-	-	-	-	-	-	1	-	2	-	-	-	-	-	-
	Si	=	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		<	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		ch/ce								1/3							
	OT	>	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
	St	=	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		<	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		ch/ce								1/2							
Hak	OT	>	-	-	-	-	-	-	3	2	-	-	-	-	-	-	-
	Si	=	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-
		<	-	-	-	-	-	-	2	3	-	-	-	-	-	-	-
		ch/ce								.../12							

ICNAF chafers

[a] cotton

France - 1967
(NEAFC simple flat guage)

Species	Gear	Mesh size group (110-114 mm)	No. of codends measured — Subareas 1,2,3, and 4: PA PES	PE	PP	MS	O
Cod	OT	>	109	–	–	–	–
& Had	Si	=	21	–	–	2	–
	& St	<	10	–	–	–	–
		ch/ce	20/142				

ICNAF chafers

Germany, Fed. Rep. - 1967
(ICES gauge)

Species	Gear	Mesh size group (110-114 mm)	No. of codends measures — Subareas 1, 2 and 3: PA PES	PE	PP	MS	O
Cod	OT	>	12	6	–	–	–
Had	Si	=	6	1	–	–	–
& Red		<	11	–	–	–	–
		ch/ce	33/36				
	OT	>	2	–	–	–	–
	St	=	3	–	–	–	–
		<	–	–	–	–	–
		ch/ce	2/5				

Note: Most of the topside chafers in use are similar in design to the ICNAF-type, but substantially narrower in width.

Poland - 1967
(ICNAF gauge)

Species	Gear	Mesh size group (110-114 mm)	No. of codends measured — Subarea 1: PA PES	Subarea 2: PA PES	Subarea 3: PA PES	Subarea 4: PA PES	Subarea 5: PA PES
Cod	OT	>	–	–	–	–	–
& Fla	St	=	2	–	–	–	–
		<	2	–	–	–	–
		ch/ce	4/4				
Cod	OT	>	–	–	–	–	–
Red	Si	=	–	4	6	–	–
& Fla	& St	<	–	4	6	–	–
		ch/ce		8/8	12/12		
Cod	OT	>	–	–	–	–	–
& Her	Si	=	–	–	–	4	–
	& St	<	–	–	–	7	–
		ch/ce				11/11	

(continued)

Species	Gear	Mesh size group (110-114 mm)	No. of codends measured				
			Subarea 1	Subarea 2	Subarea 3	Subarea 4	Subarea 5
			PA PES	PA PES	PA PES	PA PES	PA PES
Her	OT	>	-	-	-	-	-
	Si	=	-	-	-	-	-
	& St	<	-	-	-	-	3
		ch/ce					3/3

Polish chafers

Portugal - 1967
(ICNAF gauge)

Species	Gear	Mesh size group (110-114 mm)	No. of codends measured				
			Subareas 2,3 and 4				
			PA PES	PE	PP	MS	O
Cod	OT	>	35	83	-	-	-
	Si	=	16	48	-	-	-
		<	-	-	-	-	-
		ch/ce	.../182				

ICNAF chafers

USSR - 1967
(ICNAF gauge)

Species	Gear	size group (110-114 mm)	No. of codends measured									
			Subarea 3					Subarea 5				
			PA PES	PE	PP	MS	O	PA PES	PE	PP	MS	O
Cod	OT	>	-	-	-	-	-	-	-	-	-	-
Had	St	=	14	-	-	-	-	24	-	-	-	-
Red		<	17	-	-	-	-	45	-	-	-	-
& Fla												
			31/31[a]					66/69[b]				

[a] other chafers 24, Polish chafers 7

[b] other chafers 50, Polish chafers 19

UK - 1967
(NEAFC simple flat)

Species	Gear	Mesh size group (110-114 mm)	Subarea 1 PA PES	Subarea 1 PE	Subarea 1 PP	Subarea 1 MS	Subarea 1 O	Subarea 2 PA PES	Subarea 2 PE	Subarea 2 PP	Subarea 2 MS	Subarea 2 O
Cod	OT	>	–	3	2	–	–	–	–	–	–	–
	Si	=	–	–	1	–	–	–	–	–	–	–
		<	–	1	1	–	–	–	–	–	–	–
		ch/ce			.../8							
	OT	>	–	–	–	–	–	–	1	1	–	–
	St	=	–	–	–	–	–	–	–	–	–	–
		<	–	–	–	–	–	–	–	1	–	–
		ch/ce								.../3		

Chafer type not reported

USA - 1967
ICES gauge)

Species	Gear	Mesh size group (110-114 mm)	Subarea 4 PA PES	Subarea 4 PE	Subarea 4 PP	Subarea 4 MS	Subarea 4 O	Subarea 5 PA PES	Subarea 5 PE	Subarea 5 PP	Subarea 5 MS	Subarea 5 O	Subareas 3,4 and 5 PA PES	Subareas 3,4 and 5 PE	Subareas 3,4 and 5 PP	Subareas 3,4 and 5 MS	Subareas 3,4 and 5 O
Cod & Red	OT	>	–	–	–	–	–	18	–	–	1	–	–	–	–	–	–
	Si	=	1	–	–	1	–	11	1	–	–	–	–	–	–	–	–
		<	78	4	1	–	–	213[a]	3	–	–	–	–	–	–	–	–
		ch/ce			8/85					8/247[b]							
Red	OT	>	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	Si	=	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
		<	–	–	–	–	–	–	–	–	–	–	21	3	–	–	–
		ch/ce													1/24[b]		
Sil	OT	>	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	Si	=	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
		<	–	–	–	–	–	18	3	–	–	–	–	–	–	–	–
		ch/ce								.../21[c]							
Yel	OT	>	–	–	–	–	–	3	–	–	–	–	–	–	–	–	–
	Si	=	–	–	–	–	–	8	–	–	–	–	–	–	–	–	–
		<	–	–	–	–	–	56	–	–	–	–	–	–	–	–	–
		ch/ce								15/67							
Mix	OT	>	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	Si	=	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
		<	–	–	–	–	–	92	1	4	–	–	–	–	–	–	–
		ch/ce								4/97							
Ind	OT	>	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	Si	=	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
		<	–	–	–	–	–	25	–	–	–	–	–	–	–	–	–
		ch/ce								8/25[b]							

ICNAF chafer, except b = other chafers
c = chafer type not reported

[a] Contains 18 new before use codends

Part C. Trawl Material and Mesh Size Sampling Summary for 1968

The Summary is based on data submitted by Canada, Poland, Portugal, Romania, USSR, UK and USA (UK had no returns) and presented to the 1969 Annual Meeting of the Commission as Res. Doc. 69/39.

Canada - 1968
(ICNAF gauge)

Species	Gear	Mesh size group (110-114 mm)	No. of codends measured											
			Subarea 2			Subarea 3			Subarea 4			Subarea 5		
			PA PES	PE	PP	PA PES	PE	PP	PA PES	PE	PP	PA PES	PE	PP
Cod	OT	>	-	-	-	12	4	-	10	1	3	-	-	-
	Si	=	-	-	-	5	9	-	4	14	8	-	-	1
		<	-	-	-	6	5	2	11	16	13	-	-	-
		ch/ce					28/43			38/80			1/1	
	OT	>	7	-	-	26	3	4	6	2	1	-	-	-
	St	=	13	-	-	17	4	-	-	2	2	-	-	-
		<	14	-	-	15	7	2	1	2	2	-	-	-
		ch/ce		0/34			0/78			0/18				
Had	OT	>	-	-	-	-	-	-	2	-	1	-	-	-
	Si	=	-	-	-	-	-	-	2	-	2	1	2	-
		<	-	-	-	-	-	-	3	2	4	1	-	2
		ch/ce								4/17			3/6	
	OT	>	-	-	-	-	-	1	2	1	1	-	-	-
	St	=	-	-	-	1	-	-	-	-	8	-	-	-
		<	-	-	-	-	-	-	1	-	-	-	-	-
		ch/ce					0/2			3/13				
Red	OT	>	-	-	-	1	5	6	100	21	84[a]	-	-	-
	Si	=	-	-	-	3	1	-	8	5	-	-	-	-
		<	-	-	-	-	3	-	-	1	-	-	-	-
		ch/ce					17/19			58/223				
	OT	>	-	-	-	-	1	-	1	-	1	-	-	-
	St	=	-	-	-	-	-	-	-	1	-	-	-	-
		<	-	-	-	-	-	-	-	-	-	-	-	-
		ch/ce					0/1			1/3				
Gre	OT	>	-	-	-	-	-	-	-	-	-	-	-	-
	Si	=	1	-	-	-	-	-	-	-	-	-	-	-
		<	-	-	-	-	-	-	-	-	-	-	-	-
		ch/ce		0/1										
Fla	OT	>	-	-	-	25	9	-	1	1	-	-	-	-
	Si	=	-	-	-	15	11	1	3	2	-	-	-	-
		<	-	-	-	2	3	4	-	9	2	-	-	-
		ch/ce					10/70			6/24				
	OT	>	-	-	-	57	12	33	4	2	1	-	-	-
	St	=	-	-	-	13	5	2	-	-	-	-	-	-
		<	-	-	-	2	8	1	2	3	1	-	-	-
		ch/ce					0/133			0/13				

[a] cotton 4.

(continued)

Species	Gear	Mesh size group (110-114 mm)	No. of codends measured: Subarea 4, PA PES	PE
Pol	OT	>	1	1
	St	=	–	–
		<	–	–
		ch/ce	0/2	
Hak	OT	>	–	–
	Si	=	–	–
		<	–	1
		ch/ce	0/1	

ICNAF chafers

Poland - 1968
(ICNAF gauge)

Species	Gear	Mesh size group (110-114 mm)	No. of codends measured: Subarea 2, PA PES	Subarea 3, PA PES	Subarea 4, PA PES	Subarea 5, PA PES
Cod	OT	>	–	–	–	–
Red	St	=	14	13	–	–
Fla		<	–	–	–	–
		ch/ce	14/14[a]	13/13[b]		
Her	OT	>	–	–	12	5
Mac	Si	=	–	–	–	–
		<	–	–	–	–
		ch/ce			.../12[c]	5/9[c]
	OT	>	–	–	10	4
	St	=	–	–	–	–
		<	–	–	–	–
		ch/ce			.../10[c]	4/4[c]

[a] Polish chafer 8
Multiple flat 2
Other chafers 4

[b] Polish chafer 7
Multiple flap 3
Other chafers 3

[c] Polish chafer

Portugal - 1968
(ICNAF gauge)

Species	Gear	Mesh size group (110-114 mm)	No. of codends measured, Subareas 1,2,3,4: PA PES	PE
Cod	OT	>	-	-
	Si	=	14	55
		<	29	79
		ch/ce	18/177	
	OT	>	10	11
	St	=	-	-
		<	-	-
		ch/ce	7/21	

Other chafer

Romania - 1968
(ICNAF gauge)

Species	Gear	Mesh size group (110-114 mm)	No. of codends measured, Subarea 5: PA PES
Her	OT	>	15
	St	=	-
		<	-
		ch/ce	15/15

Polish chafer

USSR - 1968
(ICNAF guage)

Species	Gear	Mesh size group (110-114 mm)	No. of codends measured: Subarea 1 PA PES	Subarea 2 PA PES	Subarea 3 PA PES	Subarea 5 PA PES
Cod	OT	>	1	-	9	-
	St	=	-	-	15	-
		<	9	-	31	-
		ch/ce	10/10[a]		55/55[b]	
Cod Had Fla	OT	>	-	-	1	-
	Si	=	-	-	8	-
		<	-	-	-	-
		ch/ce			0/9	
	OT	>	-	24	-	-
	St	=	-	33	-	-
		<	-	-	-	-
		ch/ce		57/57[a]		

a Polish chafer

b Polish chafer 43
Other chafers 12

(continued)

Species	Gear	Mesh size group (110-114 mm)	No. of codends measured			
			Subarea 1	Subarea 2	Subarea 3	Subarea 5
			PA PES	PA PES	PA PES	PA PES
Her	OT	>	-	-	-	50
Sil	Si	=	-	-	-	-
		<	-	-	-	-
		ch/ce				0/50
	OT	>	-	-	-	14
	St	=	-	-	-	-
		<	-	-	-	-
		ch/ce				0/14

USA - 1968
(ICES and ICNAF gauges)

Species	Gear	Mesh size group (110-114 mm)	No. of codends measured						
			Subarea 3		Subarea 4		Subarea 5		
			PA PES	PE	PA PES	PE	PA PES	PE	PP
Cod	OT	>	-	-	76	3	320	6	-
Had	Si	=	-	-	-	-	36	1	-
		<	-	-	-	-	19	-	-
		ch/ce			7/79[a]		0/382[b]		
Red	OT	>	21	3	-	-	-	-	-
	Si	=	-	-	-	-	-	-	-
		<	-	-	-	-	-	-	-
		ch/ce	0/24[c]						
Sil	OT	>	-	-	-	-	112	-	-
	Si	=	-	-	-	-	-	-	-
		<	-	-	-	-	-	-	-
		ch/ce					0/112[a]		
Yel	OT	>	-	-	-	-	88	-	-
	Si	=	-	-	-	-	-	-	-
		<	-	-	-	-	-	-	-
		ch/ce					0/88[a]		
Mix	OT	>	-	-	-	-	59	2	4
	Si	=	-	-	-	-	-	-	-
		<	-	-	-	-	-	-	-
		ch/ce					0/65[a]		
Ind	OT	>	-	-	-	-	30	-	-
	Si	=	-	-	-	-	-	-	-
		<	-	-	-	-	-	-	-
		ch/ce					8/30		

a ICES gauge
b ICES and ICNAF gauges
c Subareas 3,4 and 5

ICNAF chafer 7
Other chafer 8