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French Research Report, 1967

A. Subareas 1, 2, 3 and 4  
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A total of 150,342 tons of cod was taken by metropolitan French vessels in the Convention Area in 1967.

Subarea 1

A. Status of the Fisheries

In 1967, 43,347 tons of cod were caught in Subarea 1 between April and October. Best catches took place in May in Div. 1D and 1C and in June in 1B.

Subarea 2

A. Status of the Fisheries

Subarea 2 was frequented almost all year. Best catches were made in Div. 2J in February and April and especially from September to November. A total of 24,660 tons was taken from the subarea.

Subareas 3 and 4

A. Status of the Fisheries

In Subarea 3, where 69,898 tons were taken, fishing began in February. Best catches were made in March in Div. 3Pn, 3Ps and 3M, then in April and July in 3L. In Div. 3K, fishing was carried out all year, however, best catches were made from September to November.

Only 12,437 tons of cod was fished from Subarea 4, 10,460 tons of which came from Div. 4R mainly from January to April.

B. Special Research Studies

Observations were made in these subareas from the oceanographic trawler *Thalassa* in March and April between 46°00' and 42°50' from St. George Bay to Emerald Bank.

I. Environmental Conditions

Six hydrographic sections consisting of 72 stations were made as follows:

- 1 - from the bank southeast of Grand Bank to Cape Spear;
- 2 - from St. Pierre to the Tail of the Grand Bank;
- 3 - across St. Pierre Bank (from the southern edge to St. Pierre);
- 4 and 5 - in the Laurentian Channel, perpendicular to its axis, at a point in its southeast extremity and at another at the level of Misaine Bank;
- 6 - off Halifax and across Emerald Bank.

A total of 635 temperature and salinity measurements were made on

these sections. At the same time 137 BT's were taken at fishing locations to establish temperature charts at the different levels.

We shall only present here the chart of bottom temperatures, at the different trawling locations and at Sections 2 and 6 across the Grand Banks and off Halifax, which are most representative of the hydrographic situation in the area studied.

#### Distribution of Surface and Bottom Temperatures

In the surface layer, there are the waters brought by the Labrador Current or cooled on the spot by the proximity of the shelf, and to which are added the continental waters, of which those, very cold, of the St. Lawrence occupy the major part of the shelf. Their temperature is less than  $0^{\circ}$  in the channel which separates Newfoundland from the Grand Banks, and in the Gulf of St. Lawrence; it is less than  $1^{\circ}$  in the shore areas of Nova Scotia.

These very cold waters circulate uniformly in the form of a very elongated lobe on the edge of the eastern slope of the Grand Banks which they outline at its southeast extremity, then bend toward the northwest to the trawling grounds. This front undergoes some very rapid changes due to the withdrawal or the formation of ice which had been observed off Cape Spear on the east coast of Newfoundland and off Cape Anguille in Cabot Strait but which, during the cruise, had well advanced southward.

The warmer water of the Atlantic Drift, which circulates extensively, partly penetrates the trawling grounds on the Grand Bank where we find a temperature of  $4.27^{\circ}\text{C}$ , and in the south part of the Laurentian Channel  $2.5^{\circ}\text{C}$ , and off Halifax in the Emerald Bank area  $3.58^{\circ}\text{C}$ .

With this area in full winter state, surface temperature is near the minimum. It is lowest ( $-1.8^{\circ}\text{C}$ ) in the Avalon Channel and at Cape Anguille, *i.e.*, in the immediate vicinity of the ice-pack.

The bottom temperature situation (Fig. 1), which is of more direct interest in the otter trawl fishing, is as follows.

In the Newfoundland area, cold water less than  $0^{\circ}$  which is found all along the northern edge of the banks, reaches almost to St. Pierre Island and Green Bank. The lowest temperature is found in Haddock Channel ( $-0.46^{\circ}$ ).

Elsewhere, the  $0^{\circ}$  isotherm reaches Cape Anguille and along the coast of Nova Scotia. In the latter area, the low temperatures are found on the shallows of Banquereau and Sable Island and remain below  $2^{\circ}$ .

The Labrador Current extends, as at the surface, around the edge of the Grand Bank in  $0^{\circ}$ - $3.5^{\circ}$  isotherms.

Further out to sea, in depths of 300-400 m, flows warmer water, the narrow lobe of which is marked by a thermal maximum of  $6.85^{\circ}$  off Emerald Bank and a little greater than  $4^{\circ}$  at the southeast extremity of the Grand Bank. It consists of slope water, a result of the North Atlantic Drift continuing into the Gulf Stream.

This slope water penetrates the deep areas of the "Scotian Gulf" (off Halifax  $5.70^{\circ}$ - $5.00^{\circ}$ ), of the "Gully" (between Sable Island and Banquereau Banks,  $4.40^{\circ}$ - $2.00^{\circ}$ ), and fills the Laurentian Channel and Cabot Strait where it has a temperature of over  $4.20^{\circ}$ . From the channel, it penetrates the deep areas of the northeast of St. Pierre Bank to Fortune Bay ( $3.70^{\circ}$ ) and pushes between the two parts of St. Pierre Banks, and into Halibut Channel ( $4.50^{\circ}$ - $2.00^{\circ}$ ).

This warmer water finally returns to the Grand Banks, starting from the trawling grounds and advancing northeast almost to the Virgin Rocks and southeast almost to the east flat, but its temperature decreases from  $4.00^{\circ}$ - $1.00^{\circ}$  following a mixing with the northern current.

### Vertical Distribution of Temperature

The section from St. Pierre to the Tail of the Grand Banks (Fig. 2) gives a good resume of the situation in the southern part of the Newfoundland Banks. It shows a certain vertical similarity in temperatures which is characteristic of the winter situation.

Cold Labrador and local water goes partly into the western channels occupying all the section between St. Pierre Island and Baleine Bank, giving a minimal temperature of  $-0.53^{\circ}$  at 50 m, and partly on the slopes where a real layer surrounded by a  $3^{\circ}$  isotherm shows prominently to a depth of 300 m, giving a minimal temperature of  $-0.72^{\circ}$  at 50 m depth. Between these two lobes circulates warmer slope water of  $4.27^{\circ}$ - $3.00^{\circ}$ .

On the slope, below 300 m, temperature increases to  $4.70^{\circ}$ , indicating the presence of extensive Atlantic water.

As for the section which, starting from Halifax, crosses Emerald Bank to reach the Nova Scotia slope (Fig. 3), it shows how the still very cold waters from Cabot Strait reach this latitude, widening their influence over the shallows of the Bank (minimum  $0.90^{\circ}$  to  $3.00^{\circ}$  at the edge of the slope).

The contrast in the water of the western edge of the Gulf Stream is very marked, where the temperature reaches  $10.00^{\circ}$  at 100 m, diminishing progressively with depth to  $4.00^{\circ}$  at 1,200 m.

This slope water, which penetrates widely into the "Scotian Gulf", reappears in the trough between the offshore slope and the shallows, with a bottom temperature of  $5.77^{\circ}$ .

In conclusion, and in spite of the small amount of comparable material available for this period of the year, one can say that, generally, one finds here, the classic opposition of the different formations recognized successively by Bjerkan, Beauge and Canadian oceanographers. It seems, however, that an early warming takes place in the southern Grand Bank, while a characteristic wintery situation exists in the Nova Scotia section.

### II. Observations on the Fishing

The fishing was carried out with two modified trawls (Lofoten type), one of nylon and the other of polyethelene, of 31.20 m headrope and with a stretched mesh of 140-100 mm. For stock studies, they were fitted with a 50 mm codend and a baiting of 60 mm meshes.

Results of observations by the sounder showed that the polyethylene trawl has a greater vertical opening than that of the nylon trawl, 4.20-4.50 m against 3.60-4.0 m.

### Yield of Main Species in Relation to Depth and Temperature

Of 86 trawlings, only 62 hauls which are grouped by sections were retained for calculating of yields/hour.

Commercial species were cod (*Gadus morhua*), redfish (*Sebastes marinus mentella*), American plaice (*Hippoglossoides platessoides*), haddock (*Melanogrammus aeglefinus*), grey sole or witch (*Glyptocephalus cynoglossus*).

Table 1 for main species and Fig. 4 for cod and redfish give the yields

Table 1. Average yields (kg/hr) of fish by depth and by ICNAF Divisions.

Sections	Depth (m)	No. of Stns.	Cod	Redfish	American plaice	Witch	Haddock	Skate	Argentine
<b>Section 3 N</b>									
Grand Bank	50-100	2	12.5	-	18	-	-	-	-
	100-220	1	162	460	13.3	-	5	16.7	-
	220-300	2	3227	418	33	5.5	-	4	-
<b>Section 3 O</b>									
Grand Bank	100-220	3	134	250	932	40	112	66	-
	220-300	5	145	802	200	372	416	31	-
	> 300	1	-	190	100	1450	-	-	-
Green Bank	100-220	3	207	12	23	44	116	21	-
	220-300	1	72	177	24	62	7	12	13
<b>Section 3 Ps</b>									
St. Pierre Bank	50-100	3	148	5	241	6	101	26	-
	100-220	2	329	442	38	86	205	46	-
	220-300	5	291	250	9	101	94	39	26
	> 300	1	-	251	5	19	-	-	99
Halibut Channel	100-220	2	235	28	33	26	28	25	-
Green Bank	100-220	3	336	35	16	11.5	4	63	-
	220-300	1	120	900	20	1000	-	40	80
Burgeo Bank	100-220	1	843	135	-	-	-	-	-
	220-300	1	-	989	12	36	-	2	-
Fortune Bay	100-220	1	66	125.5	13.5	65.5	38	-	-
	220-300	1	29	35	39	196	26	77	-
<b>Section 3 Pn</b>									
Bottom of Port-aux-Basques	100-220	2	297	44	1.5	1.5	2	-	-
	220-300	1	168	1940	-	-	-	-	30
<b>Section 4 R</b>									
Cape Anguille	100-220	3	636	40.5	16	6	19	3	-
<b>Section 4 Vs</b>									
Banquereau	50-100	2	-	-	66	-	-	53	-
	100-220	3	179	388	198	8	10	48	188
	220-300	2	19	272	2	22	-	36	299
Goulet	100-220	5	365	31	41	49	116	32.5	39
	220-300	1	63.5	405	15	11	490	-	-
Misaine Bank	100-220	3	1564	237	89	10	7	-	-
	220-300	1	23	182	-	153	-	-	-
<b>Section 4 W</b>									
Emerald Bank	50-100	1	68	-	5	-	67	-	-
	100-220	2	27	7.5	5	4	21.5	6.5	6
Sable Island	50-100	1	20	-	1200	-	-	200	-
	100-220	3	26.5	128	7	7	3	5	143
Canso Bank	100-220	2	492	161	87	46.5	-	7	-

obtained in kg/hr/haul, at various depths for the Newfoundland sections on the one hand (Div. 30, 3N, 3Ps, 3Pn and 4R of ICNAF) and Nova Scotia sections on the other (Div. 4Vs and 4W).

Best cod catches were made between 175 and 250 m in the two zones with a maximum yield of 1,000 and 3,650 kg. The fish figure, however, is an average of 9 hauls and the second a single haul made on Misaine Bank. In the Nova Scotia section, some good yields were made around 125 m. Generally, catches were in temperatures from 1°-3°.

Concerning redfish, it is only abundant from 175-200 m (200-700 kg/hr) in the Newfoundland region when water temperatures were greater than 3°. It appears at lesser depths on the edge of Nova Scotia (570 kg/hr at 150 m) where the waters warm more rapidly (more than 4°) and is less abundant at great depths of the same sector (maximum 300 kg/hr near 225 m).

Haddock catches varied with an average yield of 410-490 kg/hr from 220-300 m on the trawling grounds and in the "Gully". This fish is found most often from 1.50°-3° on the Grand Banks and from about 3° in the second sector.

American plaice were fished regularly from 50-200 m with an average yield of 930 kg east of Sable Island. It prefers 1°-3° temperatures.

Grey sole or witch, taken with an average yield of 40 kg/hr from 100-220 m, is most abundant at great depths reaching 1,450 kg/hr in the Grand Bank section.

Among the other species taken were included the skate, fished regularly at an average rate of 40 kg/hr, and the argentine which occurred especially in the south part of Banquereau from 150-250 m (300 kg/hr). Herring were found between Burgeo Bank and Cape Ray where catches of 300-530 kg/hr were made at 170 m in 2°-3°.

#### Observations on the Stocks and the Biology of the Main Species

1. Cod. Previous works, notably those of Templeman (1961), show that the cod population of the southern banks of Newfoundland and of Nova Scotia is divided in winter into small stocks over the slopes.

Cod of the Southwest Grand Bank have the greatest rate of growth, with maximum lengths of 120-140 cm. Spawning begins in April, ending early in July, with a maximum during the second half of May and the beginning of June.

Important concentrations were observed in winter and at the beginning of spring on the slopes southwest of the Newfoundland Banks and, more particularly, at the entrance to Halibut Channel. In these sections, certain hauls gave best results, 704-5,750 kg/hr on the cold vertical front; 580 kg/hr at the entrance to Halibut Channel; 580-1,210 kg/hr on the slope south of St. Pierre Bank. Some good catches were made off Cape Anguille, 1,260 kg/hr; in the southeast part of Misaine Bank, 800-3,650 kg/hr and in the "Gully", 1,150 kg/hr. These strong concentrations are situated most often in the zones of temperature contrast, with preference for 2°-3°.

The majority of individuals captured were 30-40 cm long (Fig. 5). The dominant mode is 39 cm in the Grand Bank region (Div. 30), 40 cm in that of St. Pierre Bank and of Green Bank (Div. 3Ps), and 44 cm on the slope east of Nova Scotia (Div. 4Vs). In each of these sectors and for deep-caught fish, there is a second less marked mode around 61-62 cm length.

No females had reached the spawning stage, some males, by contrast, were near it.

2. Redfish. The *mentella*-type dominates in all sectors. After Templeman, redfish of Nova Scotia and the southern banks of Newfoundland belong to the same stock, limited to the east slopes of the Grand Banks. They are

fished from 175-200 m, when temperatures are more than 3°.

Certain hauls took 460-800 kg/hr on the Grand Banks, 440 kg/hr on St. Pierre Bank, 900 kg/hr on Green Bank, and 980-1,900 kg/hr on Burgeo Bank.

Lengths vary, generally, from 17-35 cm (Fig. 6). In Div. 30 (southwest of Grand Bank, to Halibut Channel), modes seemed to be distributed by depths, 29 cm in 220-300 m, and 35 cm in deeper water. It is the same in Div. 3Ps (St. Pierre and Green Banks). In the other zones, lengths are no greater than 17-27 cm and young of less than 10 cm are taken on Grand and Burgeo Banks from 100-300 m.

Gonads of males and females show that the resting stage or first developmental stage is dominant, but a certain proportion of females had developed larvae.

3. American plaice. Most captured individuals were 20-35 cm and the best catches had mode lengths from 25-32 cm on St. Pierre and Grand Banks (Fig. 7).

Maximum yields occurred in Southwest Grand Banks, 930 kg/hr and east of Sable Island, 1,200 kg/hr.

4. Herring and Alewives. Best herring catches were made between Burgeo Bank and Cape Ray, 300-540 kg/hr. They were non-mature, with a modal length of 33 cm.

On the Nova Scotia Banks, some herring were also found but in small quantities, 7-10 kg on Banquereau, Misaine Bank, the "Gully" and Emerald Bank.

As for alewives, of an average length of 28 cm, they were taken on South Canso Bank and Emerald Bank, with a yield of 60 kg/hr for 3 trawl hauls.

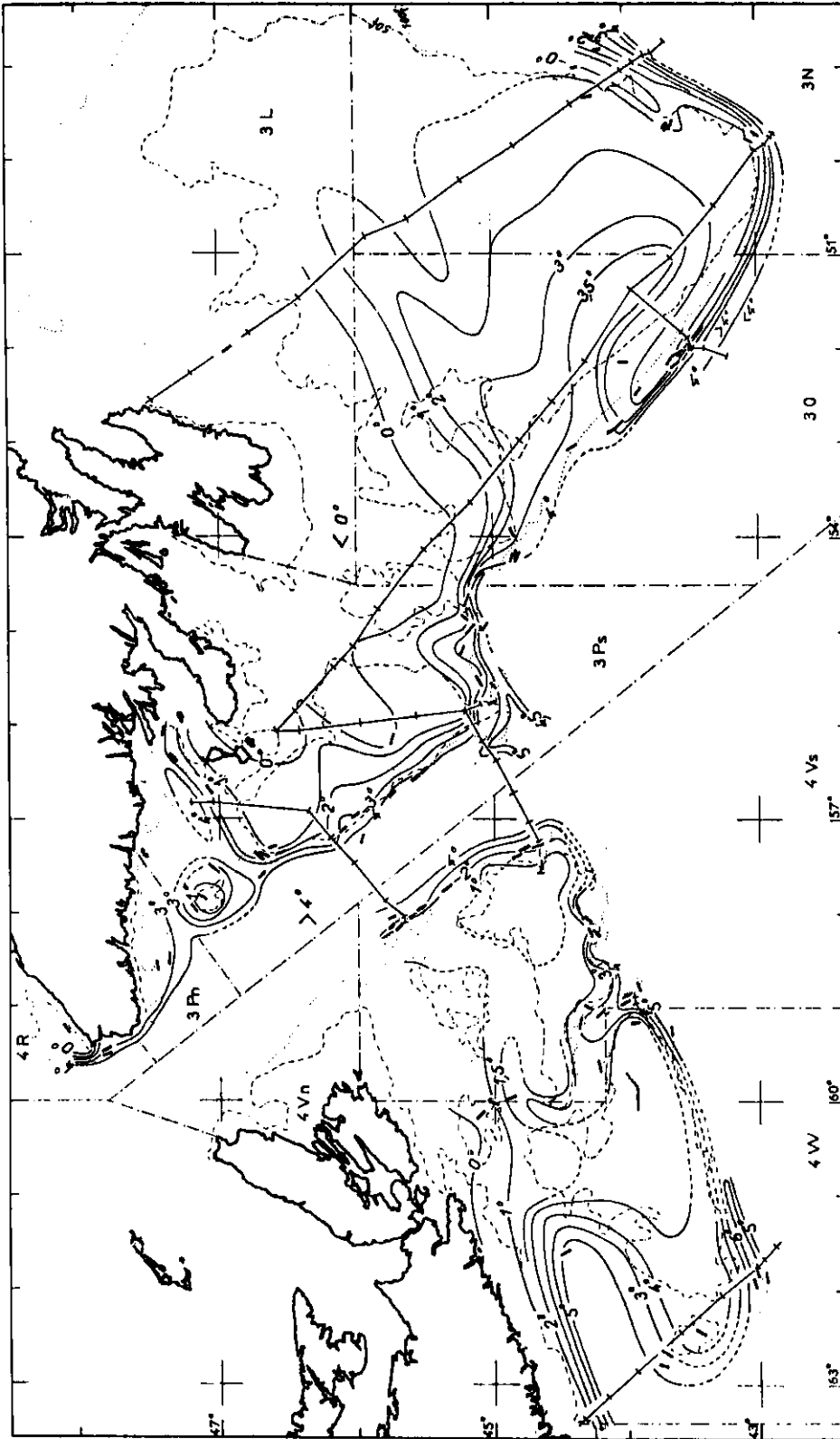


Fig. 1. Map of the region studied. The different hydrographic sections are shown in solid lines with cross marks to indicate station locations. Trawl hauls are shown by solid rectangles oriented in the direction of the haul. The isotherms show the bottom temperature. ICNAF divisions are delimited by dash-and-dot lines.

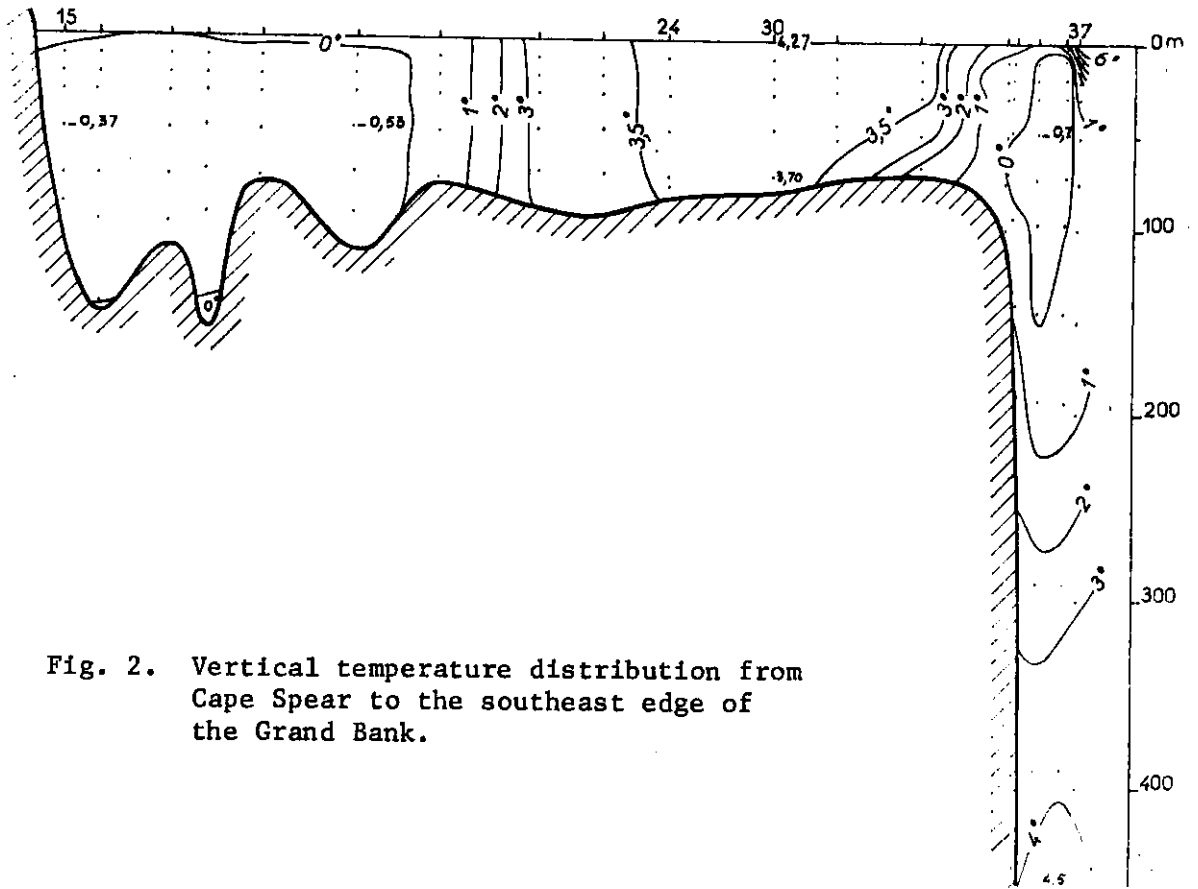


Fig. 2. Vertical temperature distribution from Cape Spear to the southeast edge of the Grand Bank.

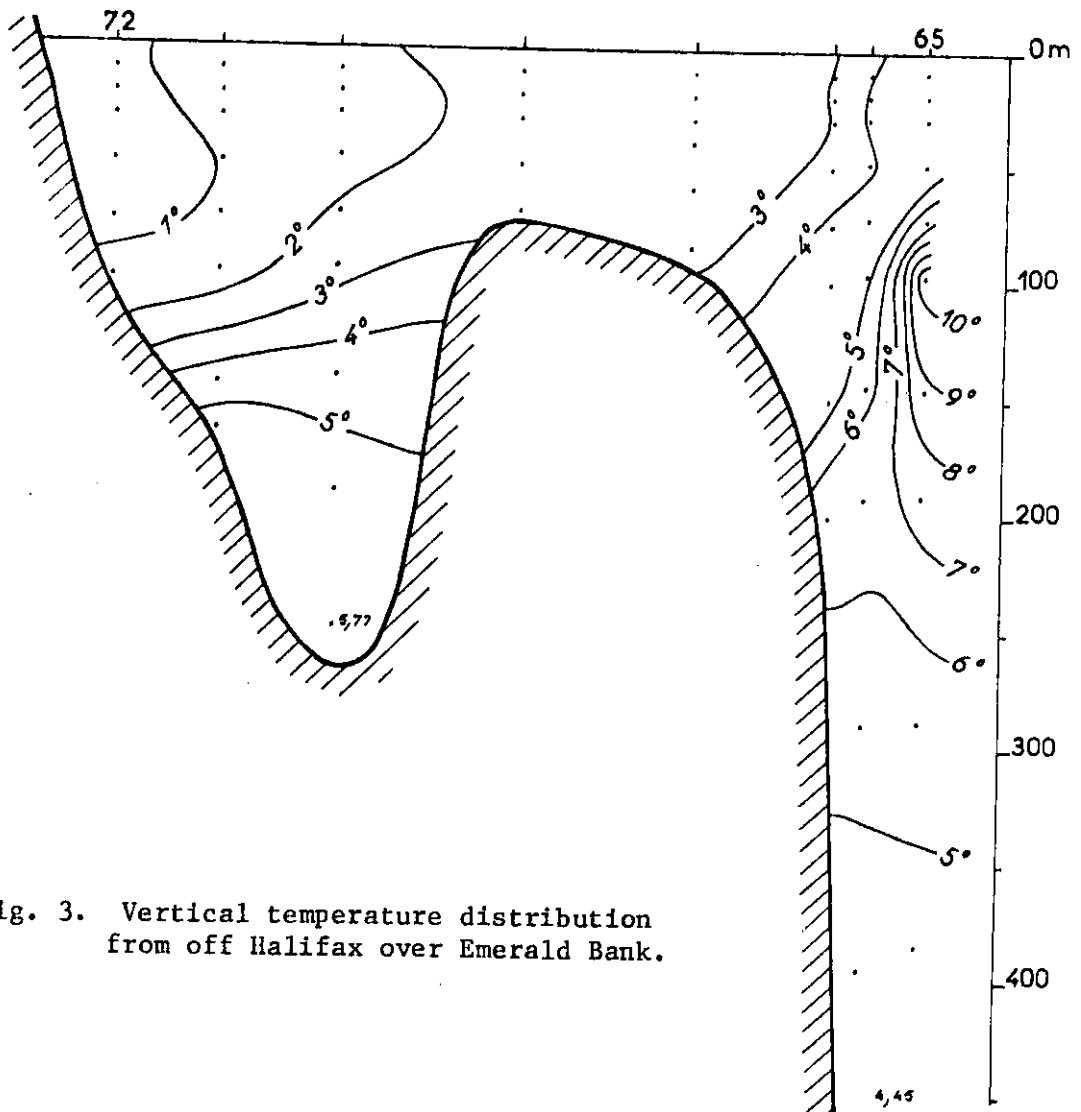


Fig. 3. Vertical temperature distribution from off Halifax over Emerald Bank.



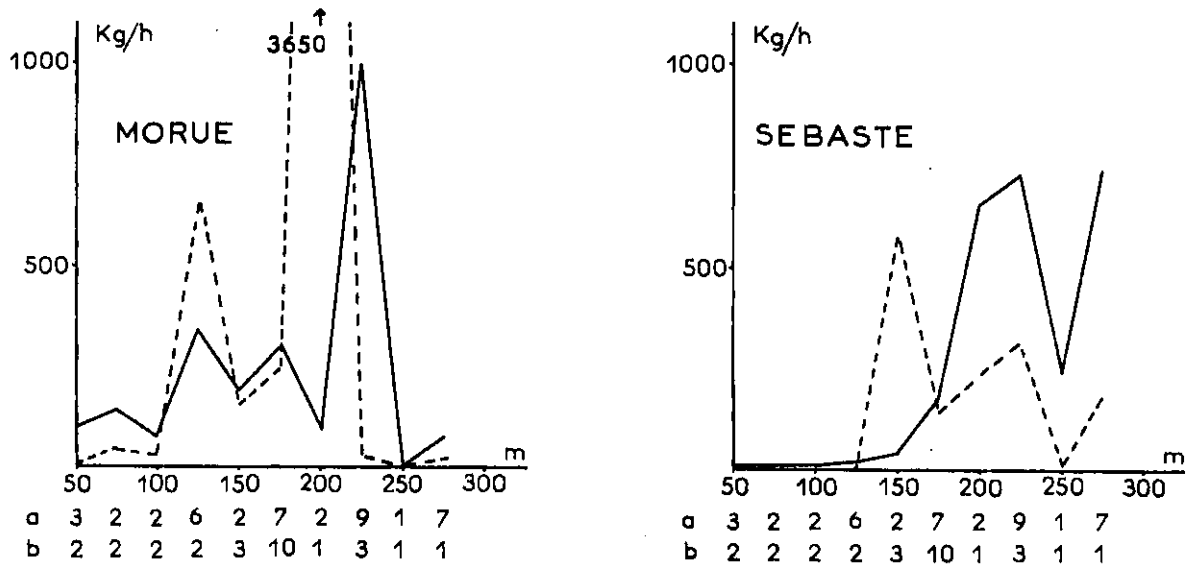


Fig. 4. Average yields (kg/hr) of cod and redfish at different depths on Newfoundland Banks (solid line) and on Nova Scotia Banks (broken line). a = number of hauls on Newfoundland Banks; b = number of hauls on Nova Scotia Banks.

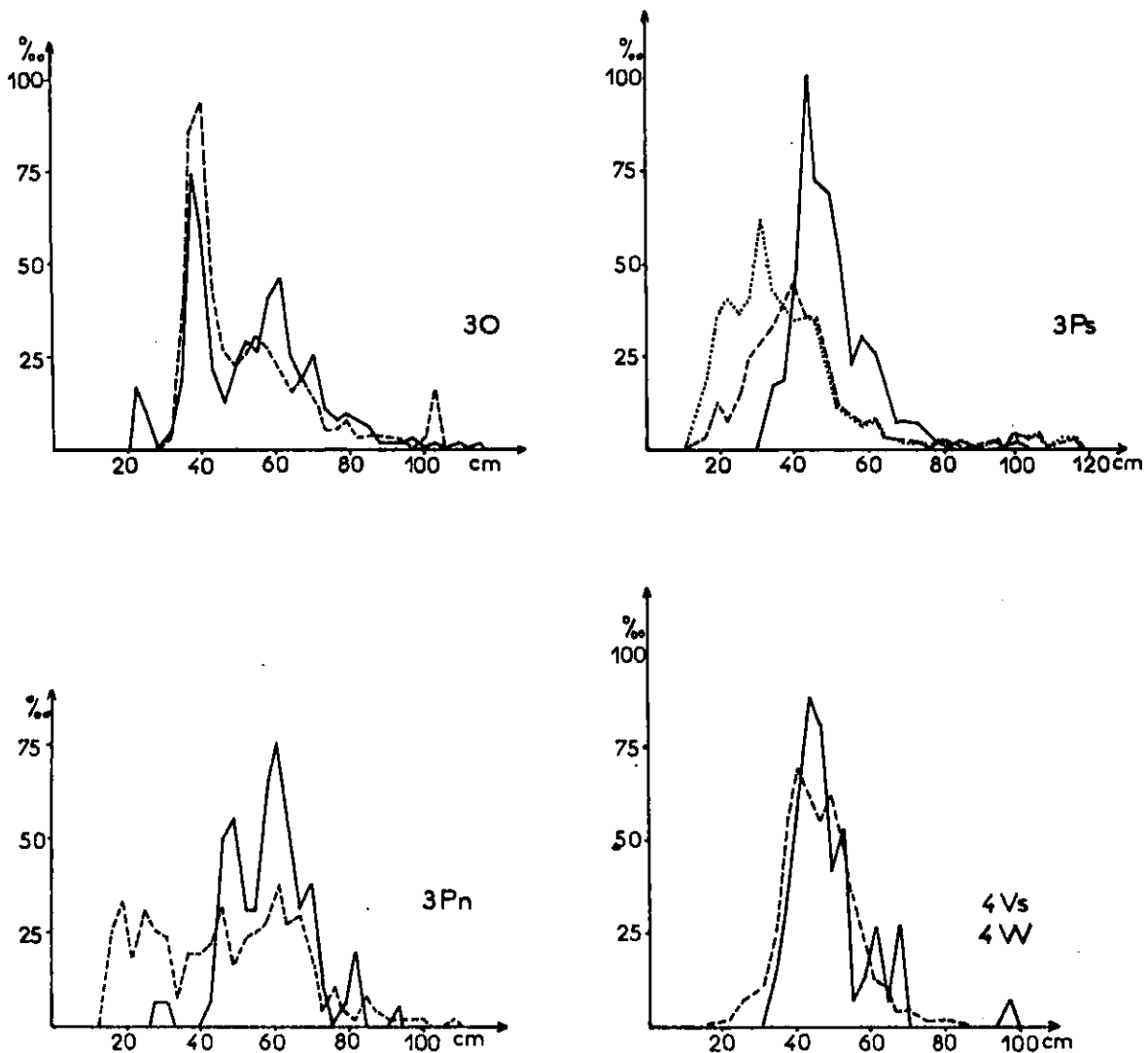


Fig. 5. Length frequencies of cod from Newfoundland Banks (Div. 30, 3Ps, 3Pn) and from Nova Scotia Banks (Div. 4Vs, 4W). Dotted line = 50-100 m; broken line = 100-200 m; solid line = 220-300 m.

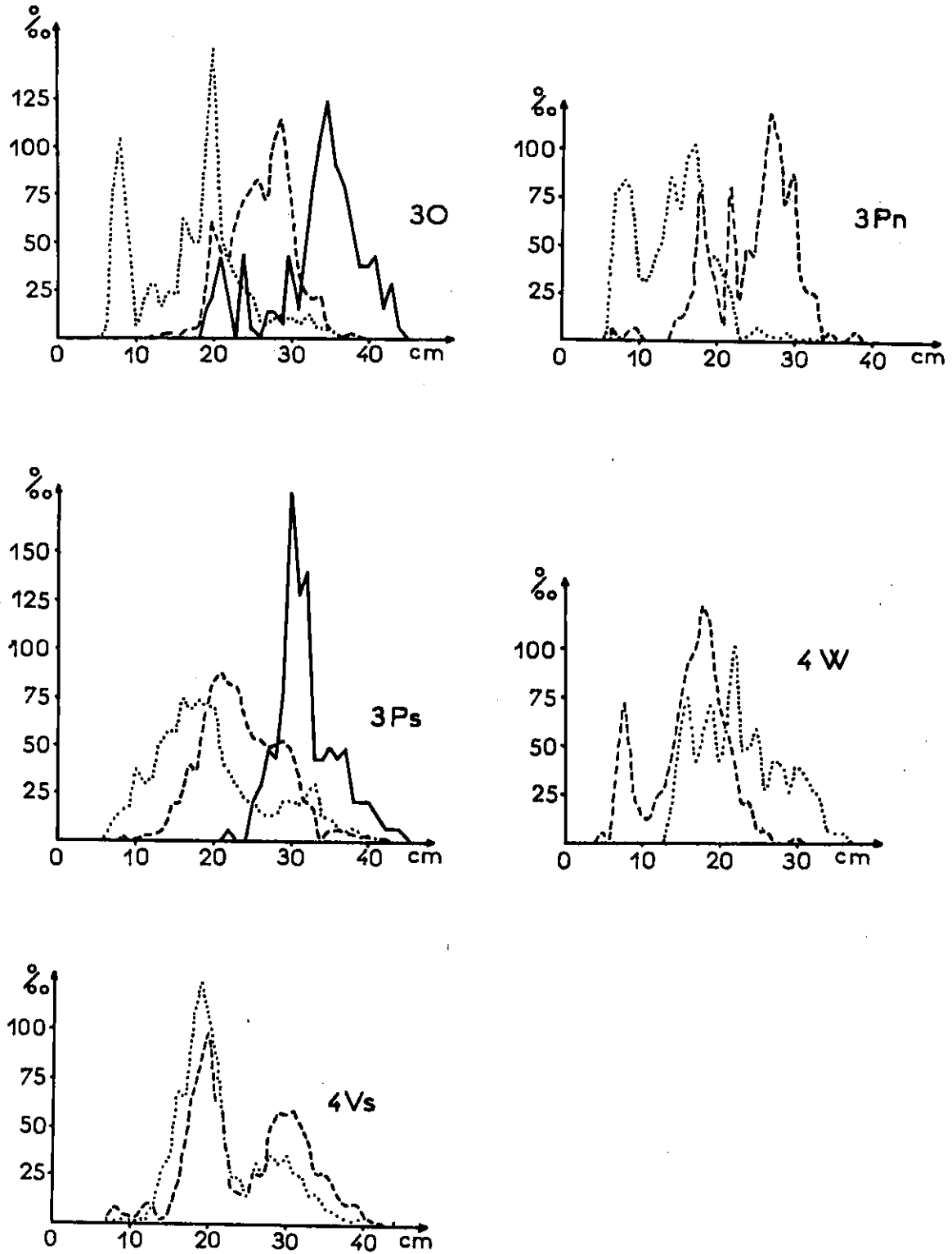


Fig. 6. Length frequencies of redfish from Newfoundland Banks (Div.30, 3Ps, 3Pn) and Nova Scotia Banks (Div.4Vs, 4W). Dotted line = 100-220 m; broken line = 220-300 m; solid line = greater than 300 m.

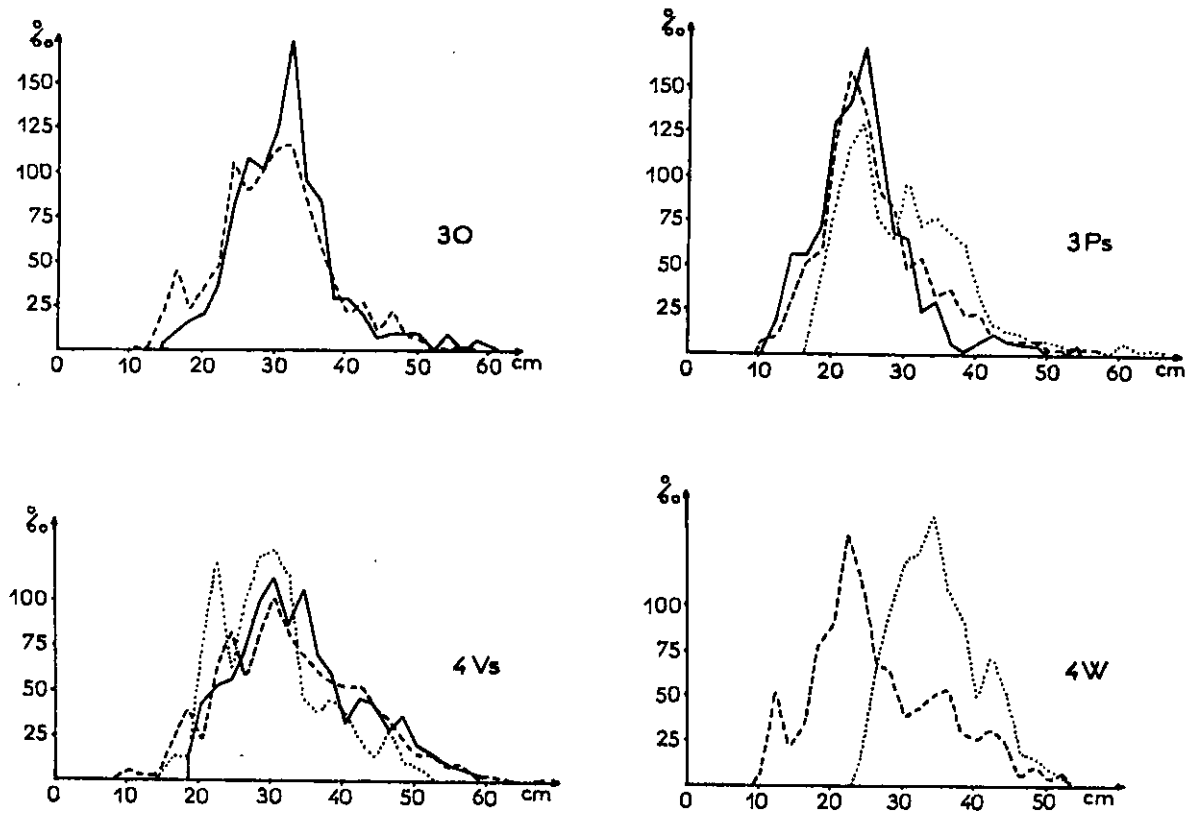


Fig. 7. Length frequencies of American plaice from Newfoundland (Div.3PO, 3Ps) and Nova Scotia (Div.4Vs, 4W). Dotted line = 50-100 m; broken line = 100-220 m; solid line = 220-300 m.