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On the Pelagic Long-line Fishery in the Holsteinsborg Deep - 1953

by
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In the season of 1953 altogether 54 Norwegian vessels participated in the Greenland fishery. The total catch was about 10,000 tons of salted cod. As in previous years the Institute of Marine Research had sent observers on board a commercial vessel to collect material on the cod fishery and the temperature conditions on the fishing banks. The observers were Birger Rasmussen and his assistant Alfred Frøland who started work in the field on 21 July. The work was mainly carried out in the Holsteinsborg Deep where great concentrations of cod in the surface layers were reported at that time.

The Trend of the Fishery.

During the month of May the Norwegian vessels had been long-lining on the western slopes of Fiskenas, Danas, Fyllas and Banan Banks where the fishery had been very satisfactory. In June-July the cod seemed to disappear from these localities, and a part of the fleet transferred their fishery to the banks off Cape Farewell - Frederikshab. Towards the end of July and in August good catches could be made in the shallow parts of the banks, but the cod was generally so small-sized that long-lining was deemed unprofitable for that reason. The whole fleet finally concentrated their activities in the Holsteinsborg Deep till the end of August when large-sized cod reappeared along the slopes of the banks.

On 12-13 August temperature observations were taken by means of a bathythermograph registering down to 270 meters. Three sections were taken across the banks, viz. one westwards from the northern edge of the Lille Hellefisk Bank, one westwards from the shallow part of the Lille Hellefisk Bank, and one section westwards from Fyllas Bank. In Figures 1 and 2 are shown the temperature conditions in the two latter localities together with corresponding observations in previous years.

In 1953 the temperatures were unusually high compared with the conditions in earlier years. In depths of 150-200 m. on the western slopes, where long-lining usually takes place, the bottom temperature on Lille Hellefisk Bank in 1949 was 0.5-1.5°C, in 1950 1-2°C, and in 1953 2-4°C. For the years 1951 and 1952 observations are lacking. On the Fyllas Bank the bottom temperature in the same depths was below 1°C in 1949, in 1950 1-2°C, in 1951 1-1.5°C. In 1953 the bottom temperatures were as high as 4-5°C. A short distance off the western slope of Fyllas Bank, we found in 1953 a belt of warm water with a central core of 7°C. In earlier years we had found cold water which was partly covered the slope itself.

The high temperatures in 1953 may perhaps explain other trends characteristic for the Greenland-fishery that year. In the Holsteinsborg Deep, for instance, in July-August unusually great concentrations of food organisms were observed. An examination of the stomach-contents of the cod showed that in particular large amounts of capelin were present, likewise sand eels, squids, fish larvæ and schizopods. Samples of the different organisms were collected, but the material has not as yet been worked up. The cod in the Holsteinsborg Deep were of considerably better quality in 1953 than in earlier years. The liver content was above normal, and the yield and quality of the oil produced perhaps the best attained in Greenland waters by Norwegian fishermen since 1949.

The Pelagic Fishery in Relation to Temperature.

The Holsteinsborg Deep is a submarine channel leading in a southwesterly direction from the great complex of fjords in the Holsteinsborg district towards the great deep of the Davis Strait. The submarine channel divides the Store- and Lille Hellefisk Bank. From the latter part of July and in August swarms of cod were present in the surface layers above the deep. At times the dense shoals were registered on the echosounder. The Norwegian vessels started fishing with floating or pelagic long-lines on 24 July. This type of fishing was tried for the first time in 1951. In later years the pelagic long-lining has become part of the ordinary fishery off West-Greenland. It is therefore of interest to make a closer study of this fishery. According to the fishermen, the cod in the Holsteinsborg Deep was larger than that caught on the shallow parts of Store- and Lille Hellefisk Bank at the same time. Trials with long-lines on Store Hellefisk Bank showed such a high percentage of small cod that the fishery was considered unprofitable. The same was the case on the southern banks. In the Holsteinsborg Deep the schools contained larger fish. The Holsteinsborg cod also distinguishes itself by its dark colours and bluish fins, while the ordinary bank-cod has a light brown colour. During the period spent in fishing with pelagic long-lines hydrographic observations were taken steadily with the bathythermograph. The general temperature patterns were largely the same all the time. From 24 July to 10 August the surface-temperatures varied between 4°C and 6°C. The temperature decreased slowly to a depth of 30-55 m. From this point down to a depth of 70-120 m. we find a rapid transition towards colder water-masses with temperatures of 2.0-2.5°C.

From 24 July to 10 August the layer of warm surface-water increased somewhat in thickness. The border of the warm surface-water (4°C) was on 24 July found at 30 m., on 31 July at 36 m., on 5 August at 40 m., and on 10 August at 55 m. The distance from the surface down to the more homogenous and colder deep-water increased in a similar way. On 24 July the border (2.5°C) was found at a depth of 72 m. and on 10 August at 120 m. Repeated fishing trials with hand-lines seemed to indicate that the cod in the Holsteinsborg Deep were fairly evenly distributed in all depths from the surface down to 150 m. The fishery with pelagic lines gave, however, the impression that heavier concentrations of fish were possibly present at certain depths, as some parts of the lines would give better catches than others. The question naturally arose if there could be a certain connection between fish-occurrence and temperature-depth.

A set of pelagic long-lines usually consists of 30 tubs, each with 180-200 hooks. Repeated control observations showed that in our case the tubs contained an average of 180 hooks. It took fairly exactly one hour to set the whole line with a speed of four knots. For every tub a buoy was set with seven fathoms drag to which the fishing line was attached. The length of fishing line between two buoys was about 386 meters, and the distance between each buoy about 246 meters. After these control measurements the long-line between two buoys should approximately describe a half-circle in the sea, with the deepest point of the long-line lying in a depth of approximately 136 meters. Figure 3 shows a schematic drawing of a pelagic long-line between two buoys as it probably stands in the sea. In the same figure is shown the temperatures in the various depths during the period of observation.

During the week 30 July - 5 August, the catches were controlled on four different settings. The frequency of catch on each single hook of the line was noted, and later the mean catches per ten hooks were computed.

From Figure 3 it will appear that the surface temperatures during the experiment vary between 4 and 6°C. The first hook of the line, nearest the buoy, stands in a depth of 13 m. At that depth the average temperature for all days are 4.76°C. The temperature decreases relatively fast downwards. At 90 m. we find a decided borderline between two temperature regions. The surface layers form a relatively warm ceiling above the underlying layers of water with temperatures between 2-2.5°C. As indicated in the figure, the pelagic long-line fishes through the warm surface-layers and some distance down into the cold water-masses.

Altogether each fish and hook was counted while fishing four settings with 9,540 hooks. The result of the countings is shown in Table I.

Table I

Hook nos.	Depth meters	Temp. C°	No. Cod	
			Total	Per 1,000 hooks
1-10	13- 36	4.70 → 3.34	248	234
11-20	36- 57		268	235
21-30	57- 76	3.34 → 2.33	323	305
31-40	76- 92		324	306
41-50	92-107	2.33 → 2.20	354	334
51-60	107-119		379	358
61-70	119-128		385	363
71-80	128-133		373	352
81-90	133-136	2.18	364	344

From the table it will appear that the fishery gives the smallest yield in the surface layers above 57 m. The temperature in this interval decreases from 4.70°C at 13 m. to 3.34°C at 57 m. In the interval between 57 and 92 m. the catches are somewhat better. The temperature here decreases from 3.34°C at 57 m. to 2.33°C at 92 m. The best catches on the line are

made between 107 and 128 m. depth, the temperatures here being 2.33 - 2.20°C. On the deepest part of the long-line from 128 to 136 m., the catches again decrease. The temperature here is about 2.18°C.

Obviously the cod in the Holsteinsborg Deep has a tendency to gather in densest shoals in the relatively cold water just below the warm ceiling found at about 90 m. However, it cannot be stated with certainty that it is the temperature conditions alone which are responsible for the varying fish density in the different layers. Also other factors may play a part. It is for instance possible that the concentration of food organisms has been particularly great just below the ceiling due to current conditions, and that the fish for that reason have been particularly attracted to that area.

In the pelagic long-line fishery it may also be anticipated that the baited hooks may have been actively fishing while sinking through the water with the result that the deepest hooks naturally would catch more fish because they pass twice through the water masses where fish are present. To clarify this point it may be explained that it takes one hour to shoot the long-line, and usually it stays four hours before it is hauled. The hauling of the whole line takes 5-6 hours.

The long-lines and hooks covered by our investigation have been actively fishing in their proper depth for seven hours on an average before being hauled. In general the fish density would be smaller on the first part of the line hauled and show an increase toward the end of the haul. This indicates that the line is mostly fishing when it is floating in its proper depth. However, the liveliness of some single cod showed that they had become hooked when the long-line passed upwards through the water. But to what extent the long-line actually catches fish on the way down and up is impossible to state with certainty.

The fishermen know from their practical experience that it does not pay to haul the long-line immediately after setting. If an appreciable great number of fish really grabbed the hooks of the sinking or rising long-line the fishermen would naturally have shortened the duration of each line setting.

Size and Age of the Cod.

The cod caught on pelagic long-lines in the Holsteinsborg Deep show comparatively small variations in size from one day to another during the fishery. The size composition on various dates is shown in Figure 4. In the period 24-29 July we find among the usual large fish of about 75 cm. a relatively great influx of smaller cod about 60 cm. in length. The mean size of the cod in the said period is 72.97 cm. In the period 31 July - 1 August the influx of small cod is somewhat less, and the mean size increases to 73.53 cm. On 10-11 August a new influx of small-sized cod occurs, whereby the mean size of the cod decreases to 71.67 cm.

The total size distribution of cod caught on pelagic long-lines in the Holsteinsborg Deep is illustrated in Figure 5. The curve has two maxima, one at 60 cm. and one at about 75 cm. Since 1949 it has been the year-class 1942 which has dominated in the long-line catches in Greenland waters, and we find that the same is the case also in 1953. Fishery investigations by other countries have proved that the year-class 1947 has been very prominent for a couple of years in the trawl catches taken on the banks and likewise in the coastal fishery of Greenland. In 1952 the 1947 year-class made up 50.7% of the Icelandic trawl-catches on the Greenland banks, while the same year-class yielded only very little to the Norwegian long-line catches of that year. It was not till the season of 1953 that this year-class entered the fishery with long-lines. The cod of the 1947-class are now six years old. In Figure 5 is drawn the size-distribution of the 1947 year-class and the 1942 year-class as represented in the long-line samples from 1953. The mean size of cod belonging to the 1947 year-class is 59.9 cm. Cod belonging to the 1942 year-class have a mean length of 76.9 cm. As it will appear further from Figure 5 the size of the two year-classes corresponds with the two maxima in the length distribution of all fish caught.

The line-caught cod belonging to the year-class 1942 has in the last few years had the following mean lengths:

Year	Age	Length, cm.
1948	6	66.5
1949	7	-
1950	8	73.0
1951	9	73.7
1952	10	75.7
1953	11	76.9

The table indicates that the year-class 1942 during the last four years has had a mean yearly increment of only 1.3 cm. The new strong year-class of 1947 appearing in the long-line catches had in 1953 a mean size of only 59.9 cm. Apparently the six year old fish born in 1947 is 6.6 cm. smaller than the six year old fish born in 1942. This fact seems to confirm the supposition that the growth conditions on the West Greenland banks has been unsatisfactory for a number of years lately.

The age-distribution of the line-caught cod in 1953 is shown in Table II. Besides the material from the Holsteinsborg Deep, a single sample was collected on Fyllas Bank on 13 August.

The 1947 year-class is poorly represented on Fyllas Bank compared to what is found in the Holsteinsborg Deep. The 1942 year-class, however, is present in both localities in the same quantities (about 29%). The mean age for all the fish in the Holsteinsborg Deep was in 1952 11.1 years, in 1953 10.0 years. The mean size of the cod in the same locality was in 1952 75.99 cm., and in 1953 72.58 cm. The reason for this decrease in mean age and size is the increasing occurrence of the relatively small cod born in 1947.

Table II

Age	Year-class	Holst.b. Deep %	Fyllas Bank %	Mean %
5	1948	0.9	1.0	0.9
6	1947	19.1	5.1	18.3
7	1946	5.3	4.6	5.3
8	1945	9.9	7.8	9.9
9	1944	5.4	3.6	5.3
10	1943	9.4	6.1	9.3
11	1942	28.5	29.0	28.6
12	1941	5.7	4.6	5.6
13	1940	4.3	7.1	4.5
14	1939	3.4	9.7	3.8
15	1938	0.6	1.0	0.7
16	1937	1.5	3.6	1.7
17	1936	2.8	7.1	3.1
18	1935	1.7	2.5	1.7
19	1934	0.9	5.1	1.2
20	1933	0.1	2.5	0.2

Figure 6 shows the length distribution of cod caught on long-lines in the different years from 1948 to 1953. The long-line, whether on bottom or pelagic, seems to be a gear with relatively great selective ability in regard to fish-size. Usually the mean length of the cod lies between 70 and 85 cm. In the years 1948-52 between 69 and 87% of the cod had a mean length of 70 to 85 cm. In 1953 71.2% of the catch was of this size.

Figure 7 illustrates the age-distribution of cod caught on long-lines in all years from 1948 to 1953. In the Norwegian long-line fishery it is particularly three year-classes which hitherto have given a great yield, viz. those from 1934, 1936 and 1942. Particularly rich year-classes seem to keep their strength over a great number of years. The year-classes 1934 and 1936 have thus given a fairly respectable yield as late as in 1952 when the fish were respectively 18 and 16 years old. However, in 1953 they had apparently lost their strength.

The year-class 1942 began to enter the long-line catches in 1948 when the fish was six years old, and it has since been the most important year-class in the long-line fishery for five years. In 1953 it still seemed to have a relatively great strength. Probably the year-class 1942 will have a decisive influence on the yield of the Norwegian long-line fishery also next year. This is not only on account of the numerical strength, but also because of the size and weight of the individuals.

The year-class 1947 which began to appear in the catches in 1953 will probably increase in numerical strength next year. On account of the small size of fish, however, it will hardly become of any decisive importance for the Norwegian long-line fishery for some years to come.

Tagging of Cod in the Holsteinsborg Deep.

In earlier reports it has been mentioned that the pelagic cod in the Holsteinsborg Deep distinguishes itself from ordinary bank-cod by its dark coloured back and bluish fins. The present author has also mentioned that these cod had possibly migrated from the fjord districts further east. It is of great interest to obtain an answer to the question. In 1953 tagging was therefore carried out in the Holsteinsborg Deep. A total of 512 individuals were marked with large yellow plastic marks fastened with silver wire to the gill cover.

Up to the end of the year 1953 altogether 13 recaptures had been reported. The recaptures were made 0-70 days after the date of tagging (Figure 8). Four individuals were recaptured in the tagging locality, all the others on Store Hellefisk Bank. The recaptures show a clear tendency for the fish to migrate northwards when leaving the Holsteinsborg Deep. It is perhaps not improbable that the pelagic shoals of cod in the Holsteinsborg Deep may be cod from Store Hellefisk Bank undertaking a feeding migration southwards in the summer and returning to the bank later in autumn. The great influx of individuals belonging to the 1947 year-class in the pelagic shoals also indicates that this may be the case. According to Paul Hansen the 1947 year-class was particularly rich on Store Hellefisk Bank in 1952, while its numerical strength decreased to the south. Our own samples show a similar trend in 1953. In the Holsteinsborg Deep 19.1% of the catches consisted of the 1947 year-class, while Fyllas Bank further south only yielded 5.1%.

It will be of interest in the coming years to study more closely the pelagic shoals of cod. Similar pelagic concentrations of cod are according to the fishermen also to be found in the submarine channel between the banks further south.

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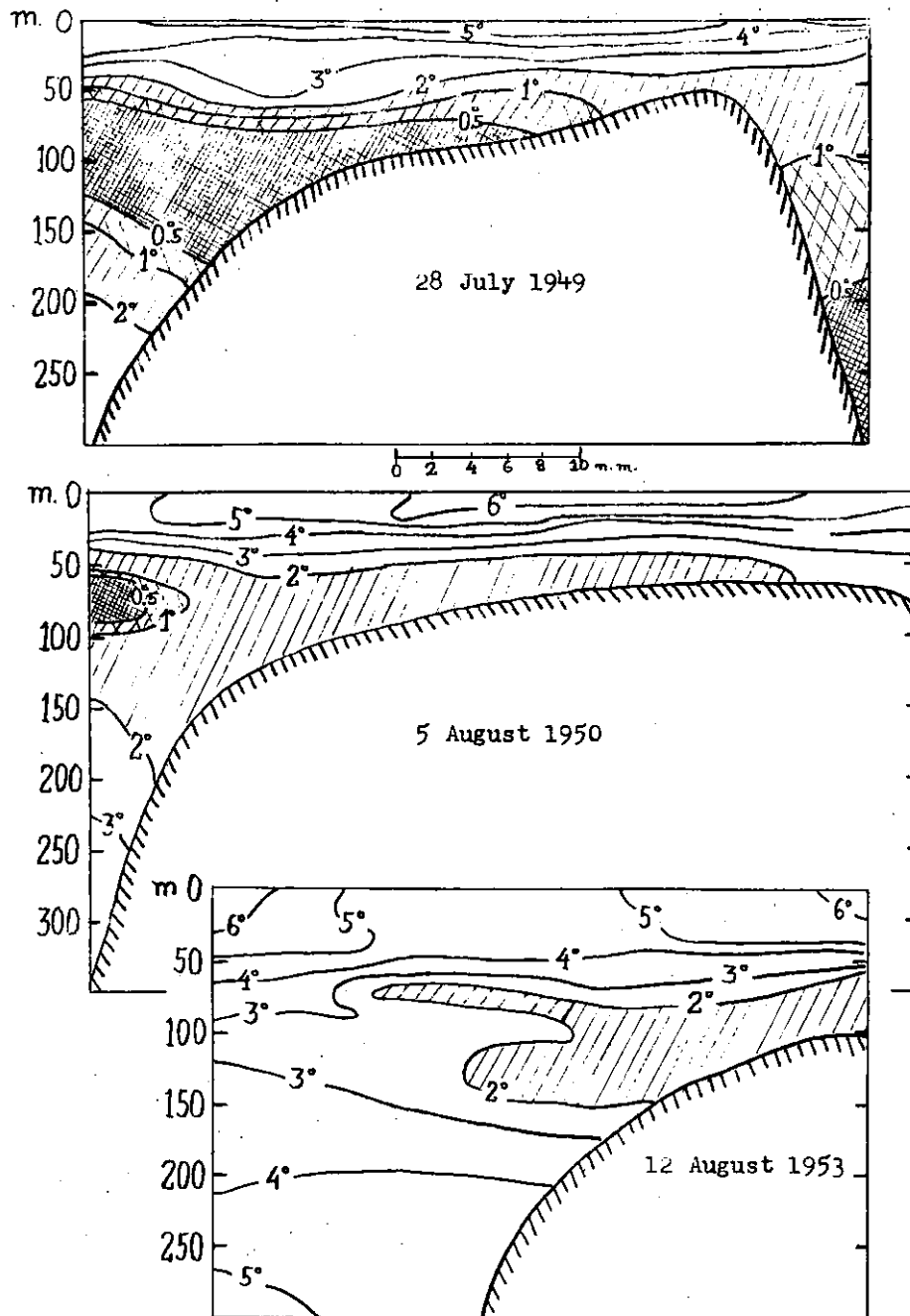


Figure 1. Lille Hellefiske Bank. Temperature 1949, 1950, and 1953.

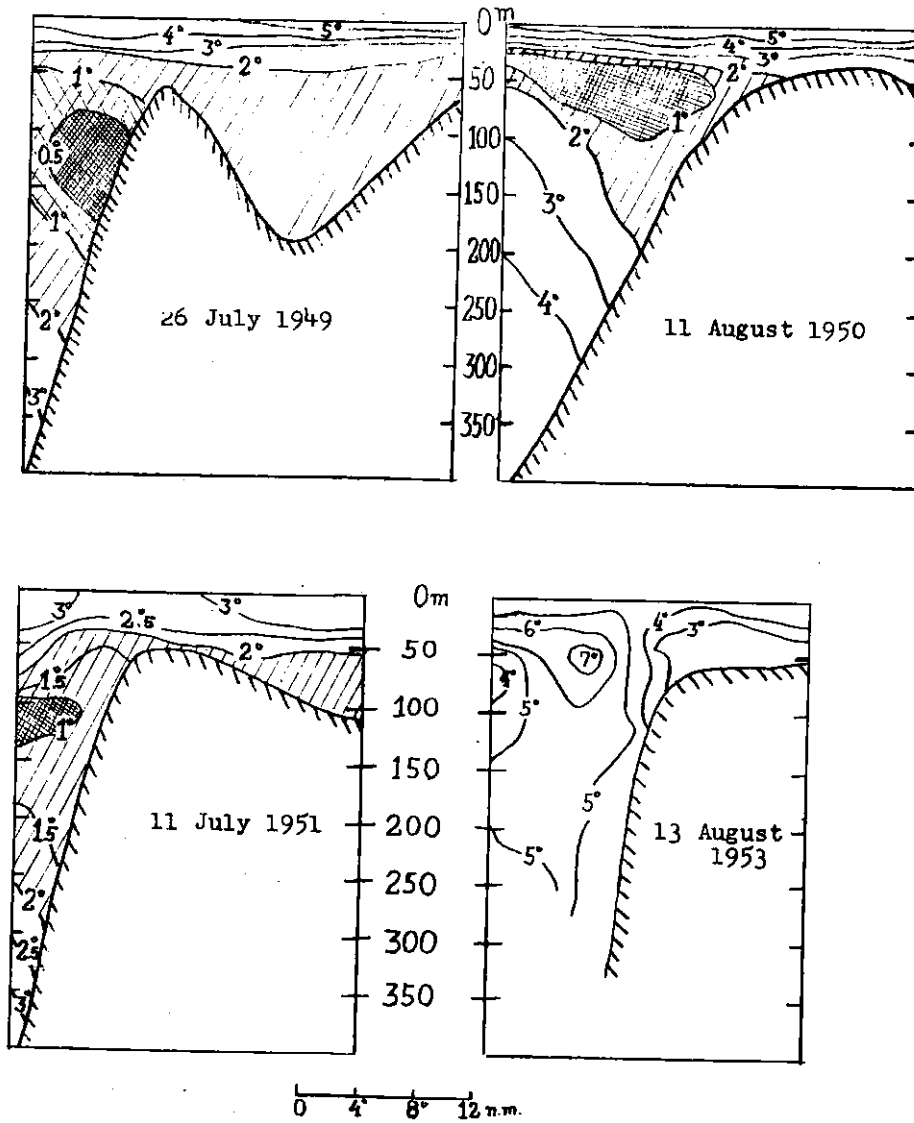


Figure 2. Fyllas Bank. Temperature. 1949, 1950, 1951 and 1953.

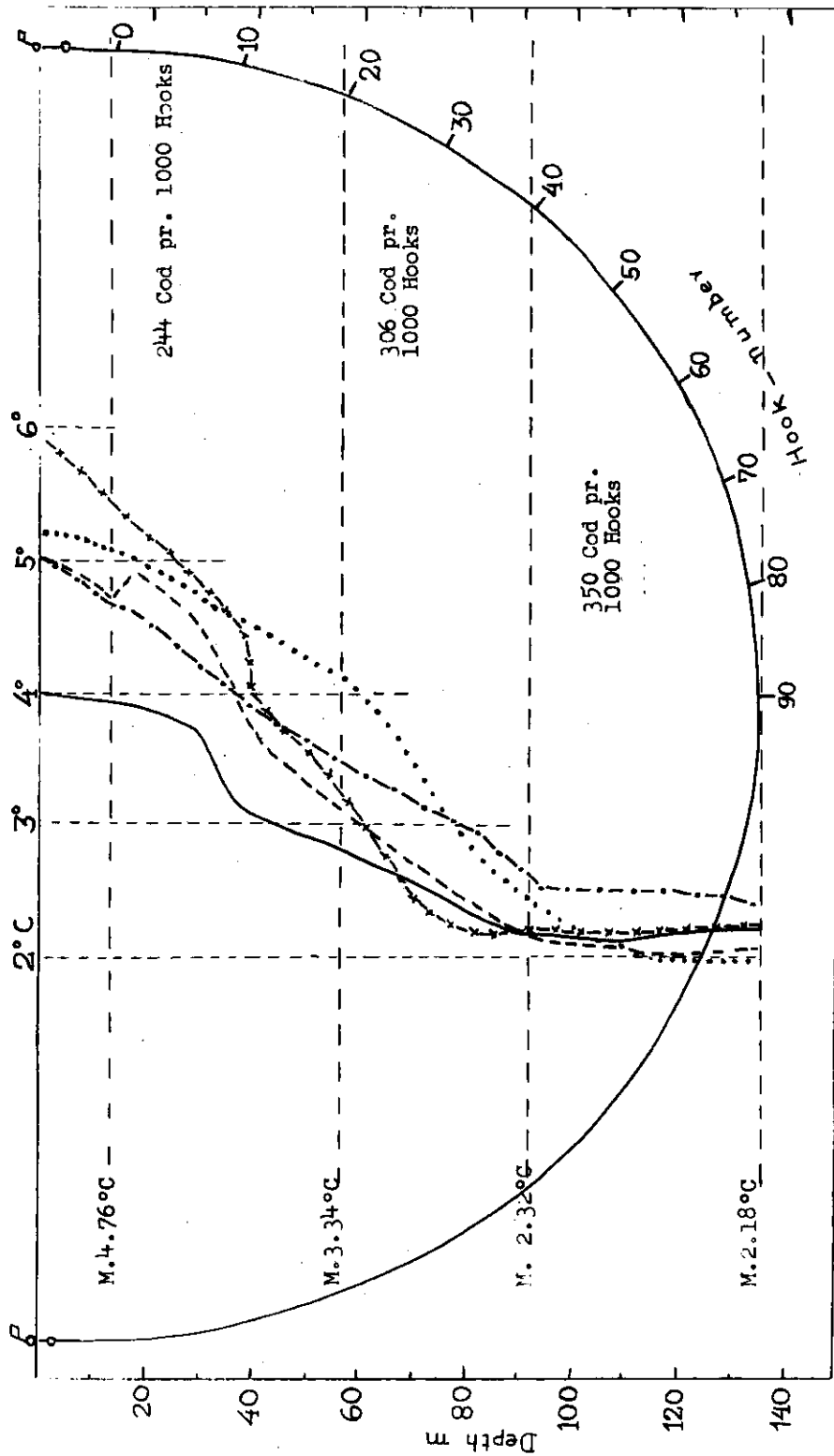


Figure 3. Schematic drawing of a pelagic long-line with temperatures and catch indicated for various depths.

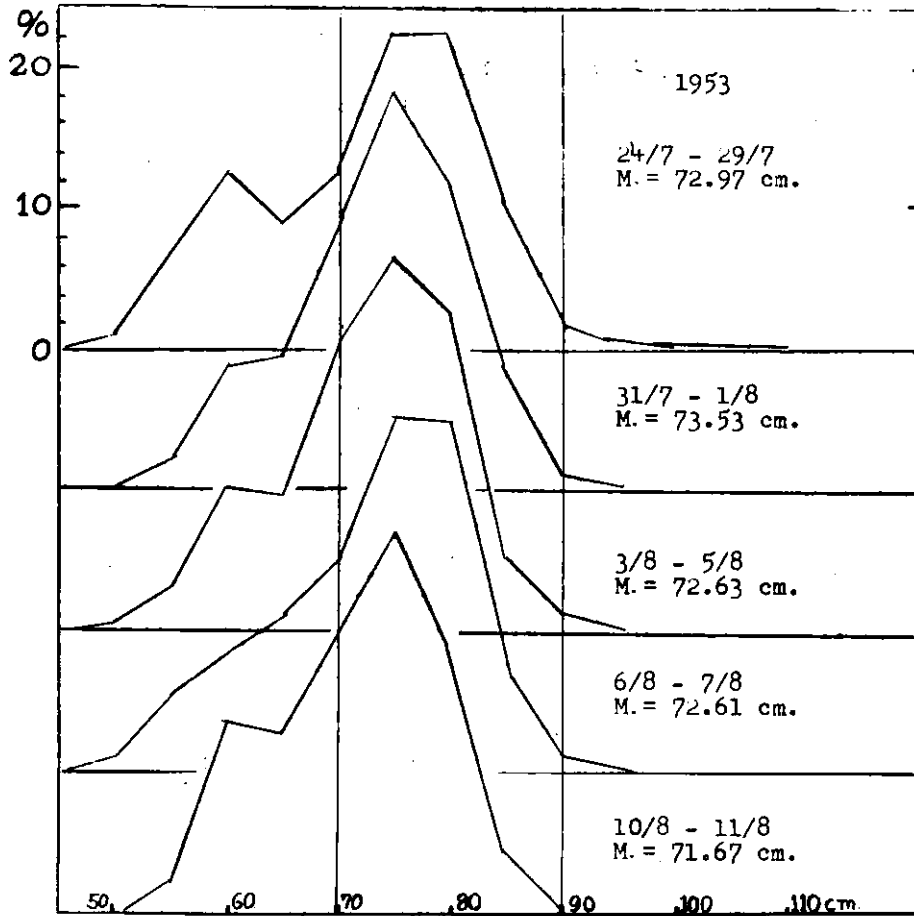


Figure 4. Size composition of cod caught on various dates in 1953.

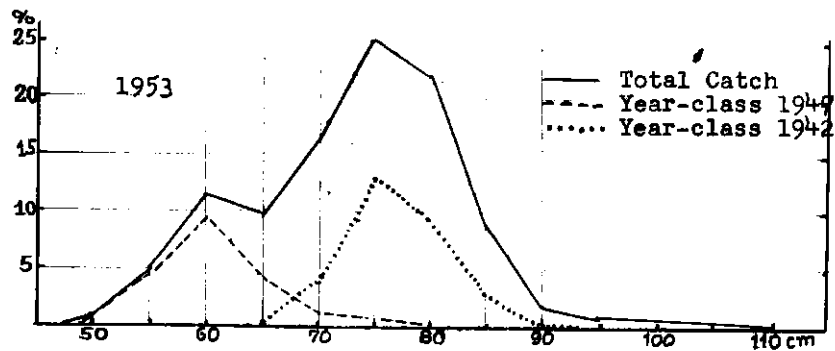


Figure 5. Total size distribution, and size of 1942 and 1947 year-class of cod caught on pelagic long-lines in the Holsteinsborg Deep 1953.

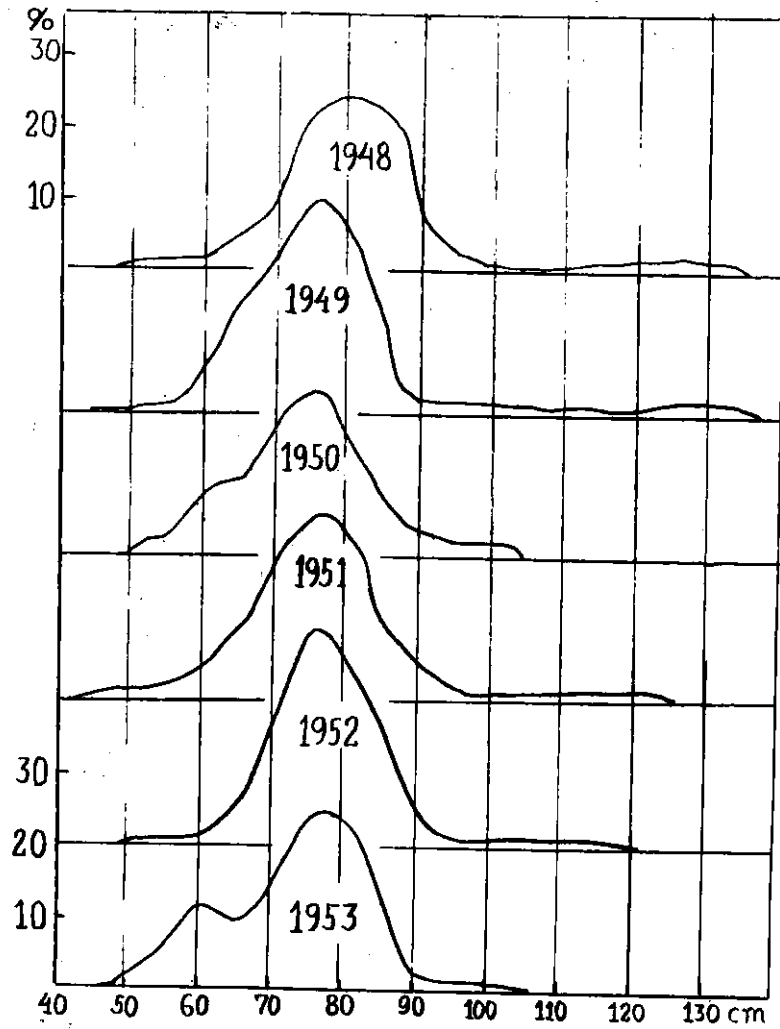


Figure 6. West Greenland, length distribution of line caught cod on off-shore banks, Norwegian vessels.

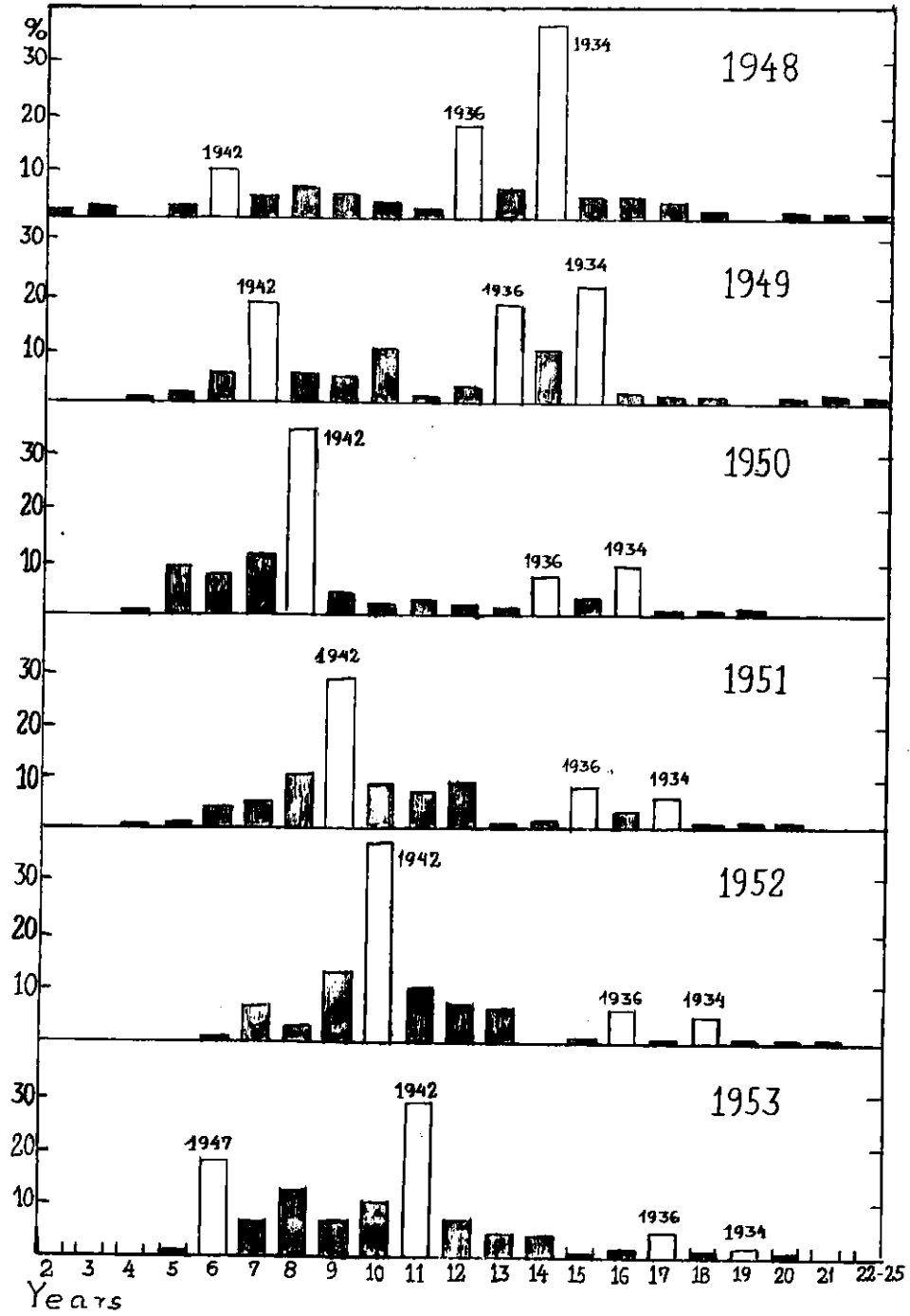


Figure 7. West Greenland, age composition of line-caught cod on off-shore banks, Norwegian vessels.

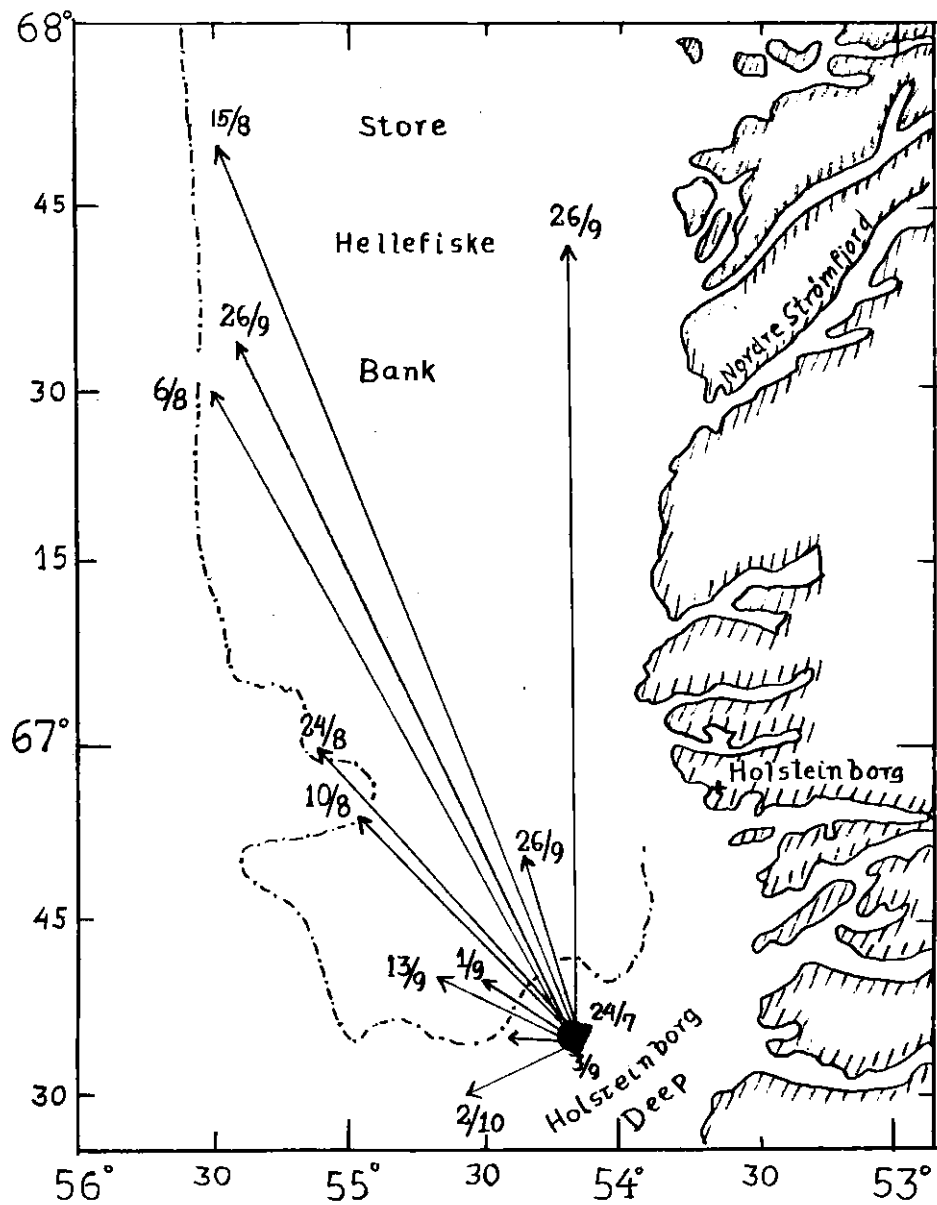


Figure 8. Cod marking and recaptures 1953.