Serial # 42

ICNAF Meet. Doc. 52/5C

The Norwegian Fishery Investigations in Greenland Waters 1948-51

by

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Cruises.

Every summer since 1948 fishery investigations have been carried out in West-Greenland waters by the Norwegian Directorate of Fisheries, Institute of Marine Research. The ships employed in this research have either been specially leased for the cruise to Greenland, or the observer with assistants have entered a commercial fishing vessel in Greenland, leasing the ship only for short intervals for special observations.

In 1948 a cruise was undertaken with the M/S "Hvidan" under the leadership of Finn Devold. In the subsequent years the fishery investigations in Greenland waters have been carried out under the leadership of Birger Rasmussen. In 1949 the M/S "Vardholm" was leased for a cruise covering the whole area from the Barents Sea to West Greenland. In 1950 the fishing vessel M/S "Eldøy", and in 1951 the fishing vessel M/S "Havmann" was employed in the fishery investigations in West Greenland waters.

Program of Research.

The Norwegian fishery investigations in Greenland waters have primarily aimed at studying the stock of cod found on the offshore banks in the Davis Strait. As regards the Greenland fjords and inshore waters, the cod here has been studied for a long series of years by the Danish scientist Dr. Paul Hansen. However, the cod population on the offshore banks, which constitutes the natural foundation for the extensive fishery carried out by several European nations, has not received the same attention. Since 1948 the cod population on the various banks has been sampled every year by the Norwegian observers. The research program has also included tagging of cod in order to study the migrations of individuals belonging to the bank population of cod. These tagging experiments are supplementary to those carried out by Paul Hansen in the Greenland fjords and inshore waters.

The Norwegian fishery investigations in Greenland waters have also included a yearly survey of the hydrographic conditions in the fishing area. It has been of particular interest to study the effect of temperature changes on the commercial fishery carried out along the western slopes of banks in the Davis Strait.

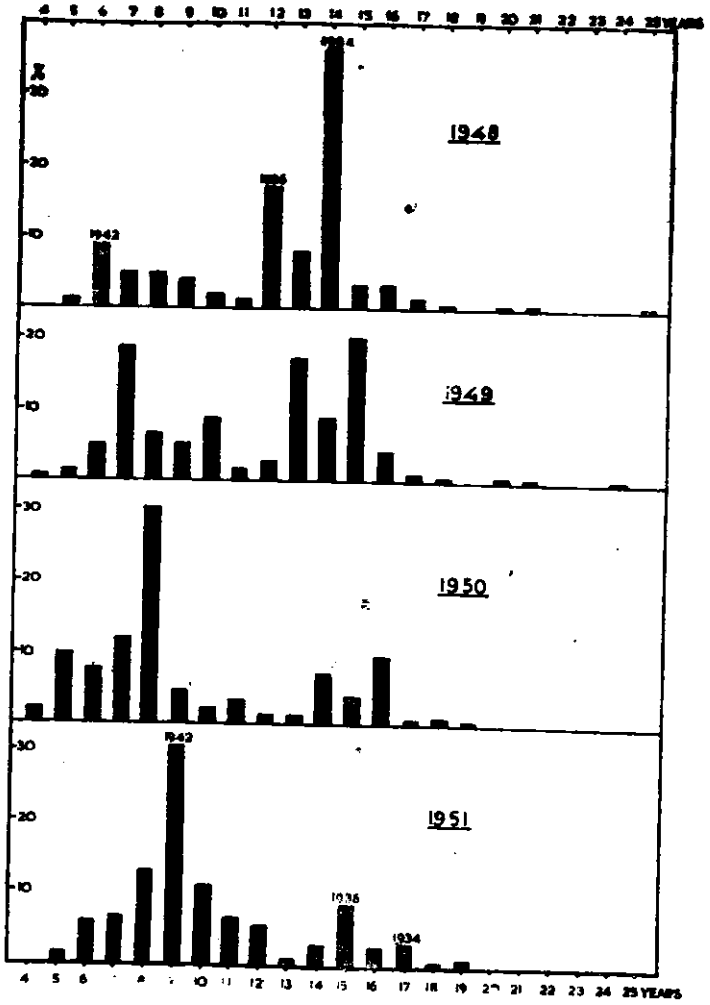

Figure 1. Age composition of cod on the offshore banks in the Davis Strait in the different seasons from 1948 to 1951.

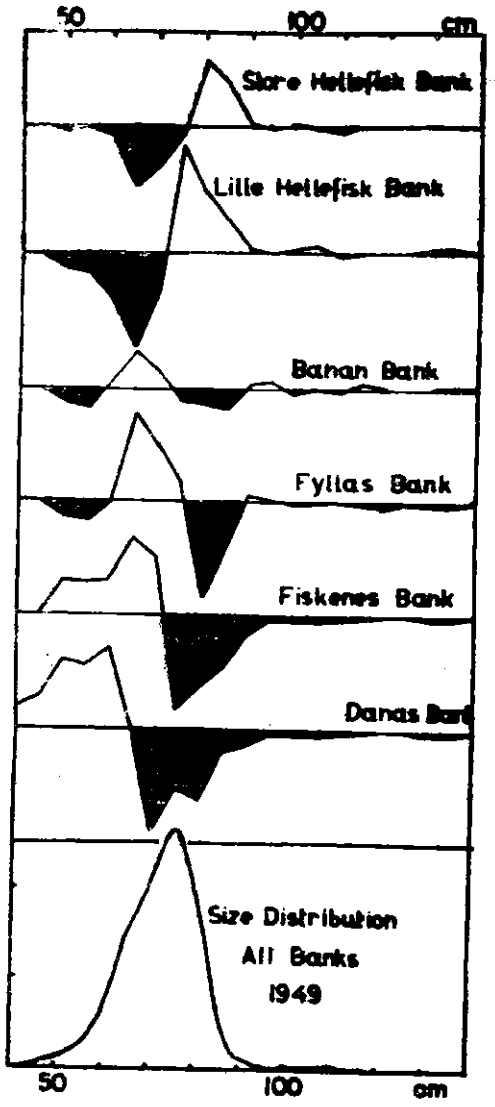

Figure 2. Size distribution of cod on the West Greenland banks (bottom), and the distribution on each bank shown as deviations from the mean in each 5 cm. group in 1949.

The cod population.

The occurrence of the great masses of cod in Greenland waters must be viewed on the background of the change of climate and of the natural conditions generally in the Arctic. The change of climate, which has taken place since the early 1920's, has had the effect that several marine forms, previously with a more southern distribution, have extended their habitat into Greenland waters. Simultaneously the more arctic species have retreated further north. Cod marking experiments have proved that particularly in the 1930's great masses of cod migrated back and forth between Iceland and Greenland. The cod wandered to Greenland in the summer in search of food, and returned to Iceland in the spring in order to spawn. During the last decades the natural conditions in the sea have become so favourable that the cod spawns both in the fjords and on the banks in the Davis Strait, and the fry and young cod are able to grow up in West Greenland waters. In all probability the favourable conditions in West Greenland waters have given rise to a separate cod population which at present has only little contact with the Icelandic stock of cod.

The climatic change and its influence on natural conditions in Greenland has been treated by several authors. The animals which enabled the native Greenlanders to make a living, among them chiefly seals, have become scarce during the last 30 years. Instead the population has become dependent upon the occurrence of cod. The establishment of a fishing industry now provides a livelihood for the natives who formerly depended on seals. The native Greenlanders do not visit the banks off the coast in order to catch cod. Their fishery is limited to the inshore waters and the fjords. However, in the summer the banks lying far offshore are visited by vessels from various European nations, among them Norway, who exploit the occurrence of cod also in these areas.

As mentioned before, the Norwegian Institute of Marine Research has carried out fishery investigations in the Davis Strait since 1948. Every year otoliths and length measurements of cod have been collected. The age composition of the cod in the different seasons from 1948 to 1951 is shown in figure 1. The analysis includes cod taken on all the offshore banks treated as one unit. It appears from the figure that in 1948 the cod born in 1934 and 1936 dominated the fishery. According to Dr. Paul Hansen the year class 1934 is the richest ever observed in the fjords and inshore waters. The variations in the size of year classes seem to correspond both in inshore and offshore waters. The cod belonging to the year class 1934 became largely sexually mature at an age of 7 years, i.e. in 1941, and in the

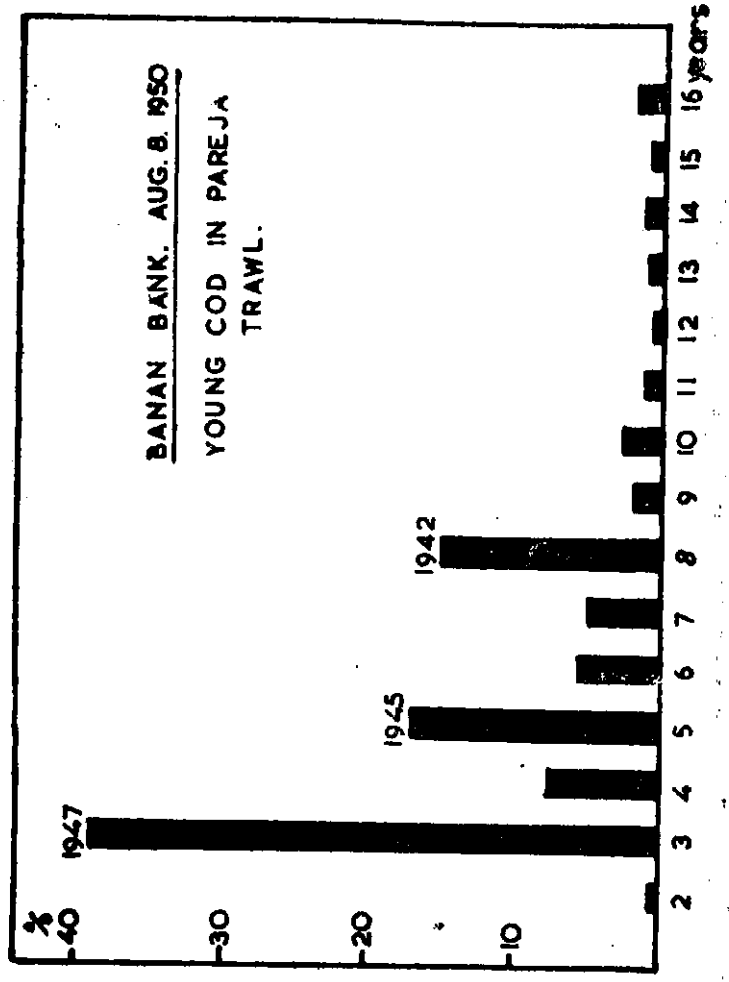

Figure 4. Age composition of small cod caught in a fine-meshed trawl on the Banan Bank in summer 1950.

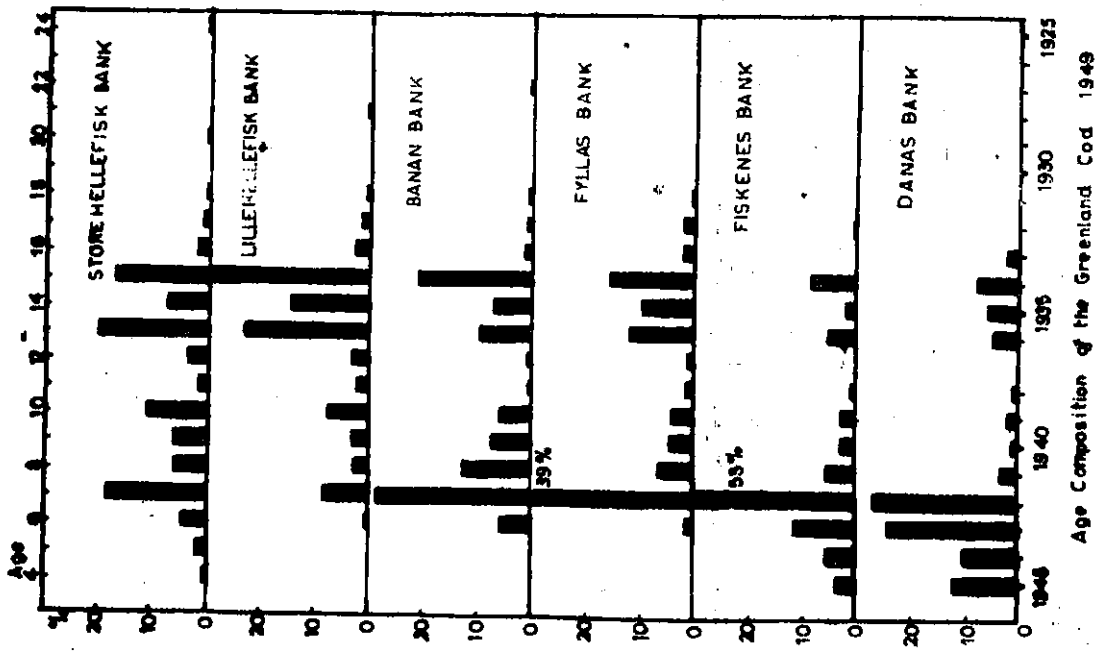

Figure 3. Age composition of cod on the West Greenland banks in 1949 from north (top) to south (bottom).

succeeding years this year class dominated in the catches of the Greenlanders. As shown in the figure the 1934-class was still rather strong on the offshore banks in 1948.

Our material shows that already in 1948 a new large year class was forthcoming in the bank fishery, i.e. the brood born in 1942. In 1948 this year class constituted 9 per cent of the catch. In 1949 cod belonging to this year class were caught in increasing numbers and made up for 19 per cent of the catch. In 1950 the percentage was increased to 30, and in 1951 the 1942 year class contributed about 31 per cent to the bank fishery with long-lines. This year class must be considered very rich.

During the investigations in 1949 we succeeded in obtaining fairly large samples of cod from each of the several banks in the Davis Strait. The samples are taken from catches taken in the ordinary course of long-line fishing. The size of the fish varies between 45 and 135 cm, the mean size of the whole catch being 74.67 cm. However, the size composition of the catches shows marked differences from one bank to another. In figure 2 the size distribution of the fish is shown as deviations from the mean of the whole area. The figure clearly demonstrates that the cod population on the northern banks contains a relatively high proportion of large fish, while on the southern banks cod of smaller size predominates. This fact also corresponds with the opinion of the commercial fishermen fishing in these waters. The mean sizes of the cod on the various banks reckoned from north to south in 1949 were as follows:

Store Hellefisk Bank	75.06 cm.
Lille Hellefisk Bank	76.65 "
Banan Bank	73.66 "
Fyllas Bank	72.25 "
Fiskenes Bank	69.12 "
Danas Bank	67.15 "

However, this variation in the size composition of the cod on the different banks is not expressed only by the size of the fish, but also by the age composition, as shown in figure 3. On the southern banks the younger age groups of cod constitute the major part of the catch, the year classes 1942 and 1943 being particularly dominant. On the northern banks we find on the other hand that older fish predominate in the catches, the large and old cod of the 1934 and 1936 group being very conspicuous.

The results of the investigations in 1949 seem to indicate that a segregation within the cod population may exist in the Davis Strait with the result that the larger and older

fish have the tendency to gather on the northern banks, while the younger age-groups seem to prefer the southern banks. Whether this segregation within the cod population is a constant feature we are not able to state with any certainty, as material covering all the banks has not been collected in subsequent years. However, our experience in later years indicates that such is the case. Both in 1950 and 1951, the commercial fishermen preferred to fish the northern banks where large-sized cod were more numerous than on the southern banks. Our material collected on Store Hellefisk Bank in 1951 shows that in this northern area still a considerable quantity of large and old fish is to be found. They are mainly 15 and 17 year-old specimens belonging to the year class 1934 and 1936. However, as shown in figure 1, these two year classes which have been so rich in preceeding years, were much reduced by 1950-51, and they will in the future probably be of no particular significance for the long-line fishery on the banks.

In the coming years it is expected that the 1942-class of cod will constitute the major part of the long-line catch on the banks. There are furthermore several younger broods which promise to become rich and which will influence the fishery in due course of time. In 1950 large samples of young cod were obtained on the Banan Bank or southern tip of Lille Hellefisk Bank by means of a fine meshed pareja trawls. The age composition in one of these trawl samples is shown in figure 4. Among the young cod we find three promising year classes, namely the broods from 1942, 1945 and 1947. As mentioned above the 1942-class has been very numerous also in the ordinary long-line catches during the last years. In the trawl sample the year class 1947 appears to be particularly rich. This group is as yet too small to enter into the long-line catches, and it will hardly appear in any numbers in the commercial fishery till 1954-55 and subsequent years. The year class 1945, although of less strength, must also be expected to become important in the future fishery, and it will probably begin to appear in long-line catches by 1952-53.

According to Dr. Paul Hansen (1951) the year classes 1945 and 1947 have been observed in great quantities in the Greenland fjords too. In regard to the year class 1947 he proclaims that it is the richest year class ever created in Greenland waters. He expects that this year class in the future will give a cod fishery of great dimension to the Greenlanders.

With our present knowledge of the cod population and its recruitment both in inshore and offshore waters it can safely be stated that the problem of overfishing in Greenland waters does not exist at present. Furthermore the problem of overfishing

will not need to be considered at least within the next 5-year period, presuming that the natural conditions do not change radically in the meantime and the fishery does not expand abnormally.

Our observations indicate that in the 1952 fishing season cod belonging to the year class 1942 will make up the major part of the long-line catch. The average size of the fish of this year class will be well above 73 cm. Also the year classes 1943-45 will to some extent add to the salt fish production although they will still be of rather small size according to Norwegian standards. During the last season (1951) the latter year classes made up for 26 per cent of the catch, while the year class 1942 singly made up for 31 per cent. It is expected that the four year classes 1942-45 as a whole will increase their contribution next year to 60-70 per cent of the catch, while the rest will be made up of older fish. On account of the influx of younger year classes and the decreasing number of old fish, the average length of the line-caught fish will in the next few years probably be somewhat less than has been the case during the seasons 1948-51.

Sea temperatures and fishery.

Off the coast of West Greenland we find a north-going current carrying partly cold water from the East Greenland Polar Current and partly warm water from the western arm of the Irminger current. Variations in the volume of the cold and warm water masses, which are intermixed on the northward run, may naturally be expected to exert a certain influence on the fishery.

On the basis of various publications on the hydrographic conditions in this area and from our own observations we are able to form an idea of the relation between changes in temperature conditions and the variations in the fishery on the banks off West Greenland. In early summer the volume of the cold East Greenland Polar Current is comparatively small, and along the western slope of the banks we may therefore find relatively warm water in depths of 150-300 meters. This is the area where the long-line fishing generally starts at this time of the year. The shallow parts of the banks are in spring and early summer covered by cold water cooled from the surface during the past winter. As the summer season advances the volume of the cold Polar Current increases till it reaches a maximum generally in July. At the same time the water covering the shallow parts of the banks becomes warmer due to the influence of the sun and air temperature. Generally the cold Arctic Current decreases in volume again during August when the warm Irminger Current gains more influence. The

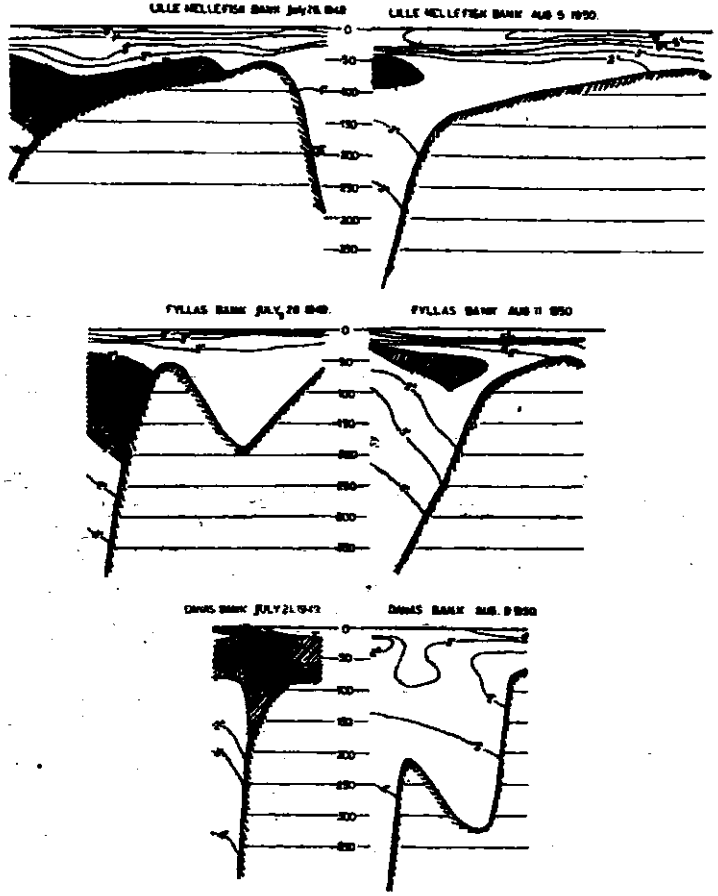

Figure 5. Temperature condition on the western slopes of the banks in the Davis Strait in 1949 and 1950 during the so-called "slack season" for the fishery.

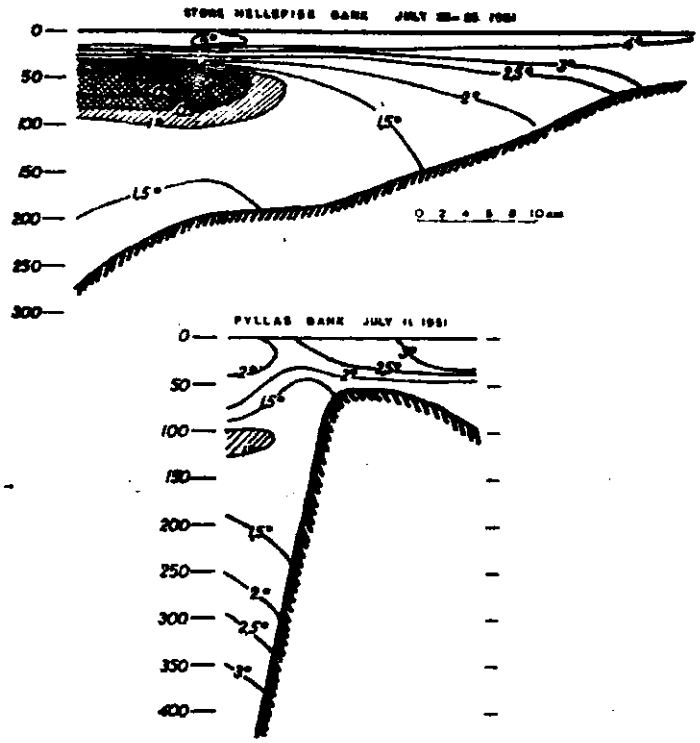

Figure 6. Temperature conditions on the western slopes of Store Hellefisk Bank and Fyllas Bank in July 1951.

current of warm water reaches its greatest volume in fall or early winter.

In general the long-line fishery along the western slope of the banks has a good period in June. Sometime in July the fishery here becomes slack, and the slack period lasts till the latter half of August. Such at least has been the experience of the Norwegian fishermen during the last three seasons.

In figure 5 is shown the temperature conditions on the western slope of Danas Bank, Fyllas Bank and Lille Hellefisk Bank during the so-called "slack period" of the cod fishery. Some distance off the slope we find in July-August a layer of cold water with temperatures usually below 1°C. Above and below this central core of cold water we find water masses with temperatures between 1 and 2°C, the cold water below 2°C stretching eastwards and covering the slopes of the banks in depths between approximately 75 and 250 meters. Above and below these depths the temperatures are higher. The shallow banks are covered with comparatively warm water.

Our experience from fishery investigations in the Spitsbergen and Bear Island area has been that cod fishing is hardly profitable where bottom temperatures are below 2°C. British trawl experiments on the Bear Island Bank have shown that bottom temperatures around 1.75°C may be reckoned as the lower limit for profitable cod catches. Our fishing experiments in West Greenland waters indicate that also here profitable fishing cannot be expected if bottom temperatures are below 2°C.

The temperature situation on the slopes of Fyllas Bank and Store Hellefisk Bank in July 1951 is shown in figure 6. In that year the Norwegian fishermen had made satisfactory catches along the western slopes of all banks in May-June in depths from 135 to 270 meters. Early in July the fishery suddenly became very slack, particularly on the southern banks. The fishermen left the southern ground and sailed northwards to Store Hellefisk Bank where the fishery still could be carried on for a while with satisfactory results. But towards the end of July the fishery became rather discouraging also here. We may presume that towards the end of June the current of cold water has increased in volume and pushed closer towards the banks where it for a while lies as a belt along the western slopes. The hydrographic sections show that in July the cold water with temperatures below 2°C covers the bottom in depths where fishing generally is carried on. The fishery in this period is slack. The cod will find more suitable temperature

conditions in deeper water or on the shallow part of the bank where the temperature in July-August lies above 3°C.

The observations in West Greenland waters indicate that the cod preferably seek shallow water when they are forced away from the slopes of the banks by the drop in temperature. In the upper water layers we find during the "slack period" better temperature conditions and a rich production of pelagic food organisms. Also on the bottom on the shallow parts of the banks, where the depths are only 40-75 meters, the cod will find rich feeding grounds. Here we can observe great swarms of sandeels and capelin at this time of the year. The cod is here able to find such quantities of fresh food that it does not take well the frozen bait generally used on the long lines.

In 1951 the fishery along the western slopes recovered gradually from the middle of August, and it remained quite satisfactory till the ships went home in early October.

The Migrations of the Bank Cod.

The Danish investigator, Dr. Paul Hansen, in 1935 published a report on his cod marking experiments in Greenland waters between 1924 and 1933. Of the cod marked in that period 71 per cent were liberated in the fjords and inshore waters, while 29 per cent were liberated on the banks. One of the conclusions reached by Paul Hansen was that there occurred only a slight interchange between the bank cod and the fjord cod and vice versa. Furthermore that particularly in the years 1929-33 a large number of cod emigrated to Iceland. Most of these emigrants were marked in the southern districts of Greenland.

The Norwegian Institute of Marine Research carried out marking experiments in the summer of 1948-51 on the offshore banks in the Davis Strait. During the four seasons altogether 1025 cod have been marked. So far a total number of 75 recaptures have been recorded from these markings, or 7.3 per cent, but still more recaptures are expected, particularly from the markings in 1950 and 1951. In the present report a preliminary survey of the results hitherto obtained will be given.

Cod Marking 1948.

Between July 31 and August 8, 1948, altogether 387 cod were marked partly on Lille Hellefisk Bank (333 ind.) and partly in different places on Store Hellefish Bank (55 ind.), (figure 7). The type of tag used was a yellow plastic disc fastened in the

gill cover with silver wire. From the 1948 markings a total of 39 tags has been returned, or 10 per cent of the cod released.

The cod marked on Lille Hellefisk Bank have given 37 recaptures, and those on Store Hellefisk only 2.

Of the cod marked on Lille Hellefisk Bank 3 were recaptured within the same season. One of them was taken not far from the marking spot, one was recaptured on the Banan Bank about 30 miles further south, while one migrated about 110 miles southwards in 80 days and was caught on the Fiskenes Bank.

In the season of 1949, one year after liberation, 23 recaptures were made, viz. 18 on the same bank where liberated, and 5 on the Fyllas Bank about 60 miles to the south.

In 1950, 2 years after liberation, 7 recaptures were recorded, viz. 2 on Store Hellefisk Bank respectively 75 and 150 miles north of marking spot, 1 in the same locality where marked, 1 on the Banan Bank 30 miles south of the marking spot, 1 at the entrance to the Fiskenes Fjord 130 miles to the south and finally 2 individuals which migrated the 1200 miles distance to Iceland, where they were recaptured respectively on January 16 and April 25 1950.

In 1951 - 3 years after liberation - 4 recaptures were recorded. One was caught in the same locality where liberated, one migrated 100 miles northwards to the southern edge of Store Hellefisk Bank, one migrated 30 miles southwards to the Banan Bank, and one migrated 60 miles southwards to the eastern edge of the Fyllas Bank.

The two recaptures of cod from the 1948 marking on Store Hellefisk Bank were made in 1950, 2 years after liberation, not far from the spot where tagged.

Summarizing the results of the 1948 marking experiment we find that of the total returns, 7.7 per cent migrated more than 30 miles northwards, 33.3 per cent migrated more than 30 miles southwards, two of the latter to Iceland, while 59.0 per cent were recaptured near the spot of tagging. Furthermore, only one of the recaptures in Greenland waters was made close to shore, while the rest were recaptured on the banks.

Cod Marking 1949.

Between July 31 and August 3 altogether 143 cod were marked, viz. 15 on Fyllas Bank and 128 on Store Hellefisk Bank (figure 8). The type of tag used was a yellow plastic disc

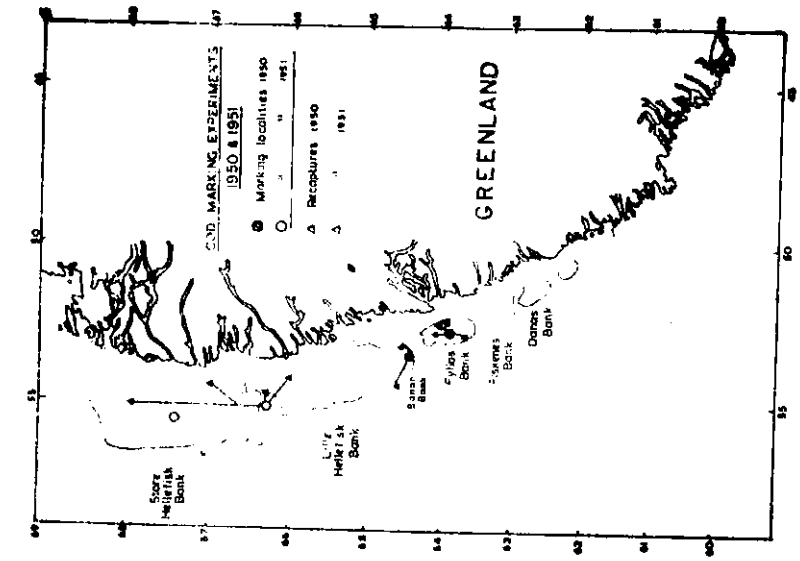

Figure 9. Cod marking experiments in 1950 and 1951 with subsequent recaptures.

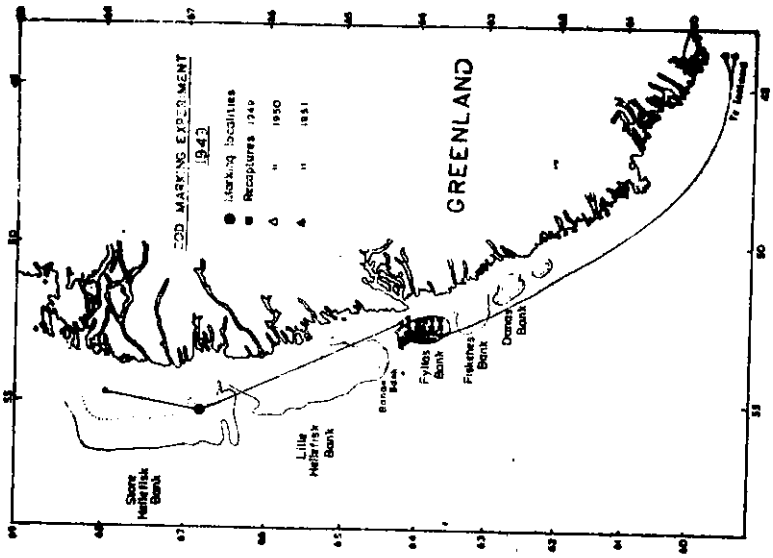

Figure 8. Cod marking experiment in 1949 and recaptures till 1951.

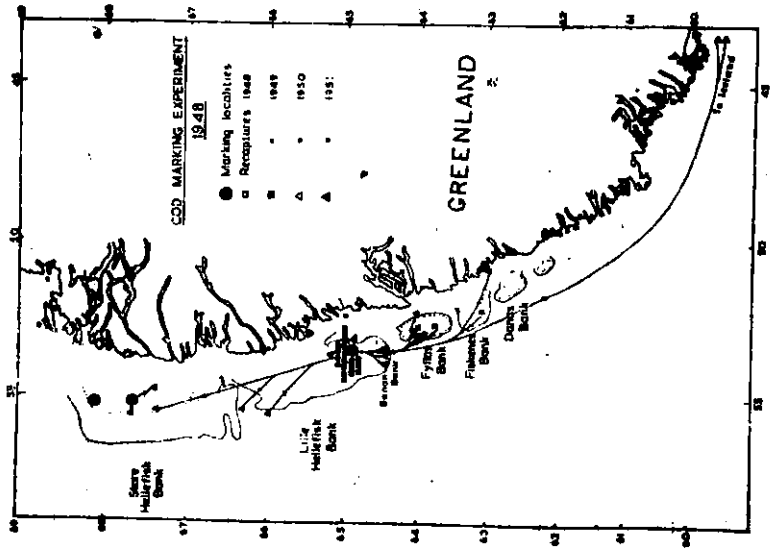

Figure 7. Cod marking experiment in 1948 and recaptures till 1951.

fastened in the gill cover with a hoop of stainless steel wire. From the 1949 markings a total of 25 tags has been returned, or 17.5 per cent of the cod released.

The cod marked on Fyllas Bank have hitherto given 23 recaptures. Within 2½ months after liberation 10 recaptures were made, all of them on the same bank where tagged. In the fishing season of 1950 - 1 year after liberation - 12 recaptures were made, 11 of them near the tagging locality, and 1 at Iceland where it was caught on June 16 about 10½ months after liberation. In 1951 only one recapture was recorded, viz. a tag returned from the south coast of Iceland on April 20, about 2 years and 9 months after liberation.

From the 15 cod marked on Store Hellefisk Bank 2 tags have been returned. One individual migrated 70 miles northwards on the same bank and was recaptured after 35 days. The other migrated 180 miles southwards to the Fyllas Bank where it was caught about 1 year after liberation.

Summarizing the results of the 1949 marking experiment we find that of the total returns 4.0 per cent migrated more than 30 miles northwards, 12.0 per cent migrated southwards including the fish emigrated to Iceland, while 84.0 per cent were recaptured in the same area where liberated. None of the cod migrated from the banks to inshore waters.

Cod Marking 1950.

Between August 6 and August 12, 1950 altogether 295 cod were marked, of which 185 were liberated on Fyllas Bank and 110 on the Banan Bank (figure 9). The type of tag used this year was a hydrostatic tube (Lea's tag) fastened to the gill cover by a hoop of stainless steel wire. From the 1950 marking experiment 6 tags have been returned, or 2.0 per cent of the cod released.

From the cod marked on Fyllas Bank 4 recaptures were recorded, all of them taken on the same bank and not far from the marking locality. Two individuals were recovered in the same season, the two others during the fishing season of 1951 - about one year after liberation.

The tagging on the Banan Bank has given 2 returns, both of them on the same bank and less than 30 miles from the marking locality. The tags were returned in 1951 about one year after liberation.

The marking experiment 1950 has shown no migrations away from the bank where the cod were marked.

Cod Marking 1951.

In the summer of 1951 altogether 200 cod were marked during the latter half of July on Store Hellefisk Bank and in the Holsteinborg Deep. The latter deep separates the Store Hellefisk Bank from the Lille Hellefisk Bank. In each locality 100 cod were marked.

The marking experiment in the Holsteinborg Deep ought to prove of particular interest. Towards the end of July 1951 large shoals of cod were observed near the surface in this region. The cod were feeding on swarms of sandeels and capelin. The body color of this shoaling cod was strikingly different from that of the ordinary bank cod. While the latter generally is marbled light brown, the pelagic Holsteinborg cod had very dark, almost black spots and a pectoral fin with bluish tint. Presumably this type of fish belonged inside the Holsteinborg fjord or neighbouring districts and had migrated out in open water in order to feed during the latter part of the summer.

From the cod marked in the Holsteinborg Deep hitherto 5 recaptures were recorded, all of them within a month after tagging. Two individuals have migrated respectively 45 and 100 miles to the north where they were recaptured in the shallow area of Store Hellefisk Bank. A third individual migrated a comparatively short distance to the east. A fourth migrated about 30 miles to the southeast and was recaptured on the northern part of Lille Hellefisk Bank. For the fifth individual data as to time and place of recovery is lacking.

Summarizing the results of the tagging experiments through all 4 seasons we find that 69 per cent of the recaptures were made in the same area where the fish were marked and these recoveries were made over a period of 4 years. This indicates that the various banks may possibly have a more or less local cod population which stays on the same bank for a succession of years. Only 8 per cent of the marked fish show a northward tendency in their migrations, while 23 per cent migrated any appreciable distance southwards, the latter figure also including the emigrants to Iceland (5.4 per cent). The results of these tagging experiments confirm the view that the bank cod only to a very small degree intermix with the populations of cod found in coastal waters and in the fjords of West Greenland.