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Pandalus Borealis stocks at Greenland
Biology, exploitation and possible protective measures

by

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ABSTRACT

The explosive development in the offshore fisheries for the shrimp, Pandalus borealis Krøyer, at the west coast of Greenland in the last few years makes neccessary that immediate measures are taken to protect the shrimp resources. This paper reviews the present knowledge of the shrimp in Greenland waters. The development in the shrimp fisheries at Greenland and in other Pandalus stocks is described, and different measures to protect the shrimp resources from overfishing are considered. A method to arrive at precautionary TACs for the offshore fisheries resulting in a total annual TAC of 26 000 metric tons of shrimps is described and discussed.

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I. INTRODUCTION

After the fatal decrease of the West Greenland cod stock (formerly the most important fishery resource of the Greenlanders) and after the salmon fishery has been restricted by international agreement the Pandalus borealis stock is now the most important resource for the Greenland fishery.

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GF has carried out research on shrimps in all the years since 1946. At the beginning the greatest attention was paid to the general biology of the shrimp and to a general knowledge of the distribution, including mapping of actual fishing grounds.

Up to the beginning of the 1960ies the research was carried out in inshore waters. However, after 1963 the research has mainly concentrated on mapping of offshore shrimp grounds, and a fairly good picture of the distribution of shrimp and of actual fishing grounds now exist throughout ICNAF Subarea 1.

The actual situation in the fisheries as described above means that the research on shrimps is now devoted to assessments of the stocks rather than to description of general biology, distribution and mapping of fishing grounds.

The present paper is intended as a contribution to a discussion of the valuation of the Greenland Pandalus stocks, but before giving a description of the methods used a short survey should be given on the biology of the Pandalus stocks and on the Greenland shrimp fishery.

II. GENERAL BIOLOGY OF THE PANDALUS STOCKS AT GREENLAND

Pandalus borealis is distributed along most of the West Greenland coast and at the southern part of East Greenland. It lives on soft bottom mainly from 150 to 500 m depth in all fjords and coastal waters with positive temperatures (mostly 1-2°C), while in threshold fjords with cold bottom water it is found only in small quantities.

The fundamental biology of the Greenland shrimp stocks was described by Horsted and Smidt (1956, 1965), Horsted (1969) and Smidt (1969). It was shown, that the shrimps at West Greenland, as in other known stocks, are protandric hermafrodites. The shrimps become ripe males when 3 years old and females when 4 or 5 years old. Spawning takes place in July-August, and the females are ovigerous until hatching takes place in April-May. In terms of time this sexual development is the same as at Spitsbergen and Jan Mayen, while a far more rapid development is found in more southern and warmer waters as in Skagerrak (Rasmussen. 1953).

Larval drift by surface currents is assumed to be essential to the recruitment of certain stocks. Thus the Disko Bay is believed to receive a contingent of larvae from the rich offshore stocks of shrimps in the deep areas north of Store Hellefiske Bank. - Further, a wider distribution of larvae explains why Pandalus borealis occurs so far north as Upernavik district. A sample from experimental trawling there (71°53'N. 55°26'W.) in 1957 showed a striking feature, as 4 years old shrimps were totally absent, while 2, 3 and 5 years olds were represented. The stock is presumably recruited from more southern areas, and it must then be supposed that the conditions for drift and/or larval survival were unfavourable in 1953.

Fluctuations in stock density have often been noticed, and in some cases it could be shown that variation in bottom water temperatures was the cause. - More or less regular variations in stock density, correlated with temperature variations, were observed in some fjords in southern West

Greenland (Julianehåb district). Inflow of warm bottom water from the Davis Strait at the end of the year was followed by increasing trawl catches (higher catch per effort) in the commercial shrimp fishery, and the migration of shrimps was confirmed by tagging experiments.

The rich and extended shrimp grounds north of Store Hellefiske Bank are regarded as an important recruitment reserve for the Disko Bay. Here in July 1964 the R/V DANA caught on average 180 kg per hour of very big shrimps in depths of 400-500 m, but in 1966 the vessel only got about 90 kg/hour on the same ground. It was further remarkable that in 1966 the commercial cutters got unusually big catches of unusually big shrimps in the Disko Bay, and that in the same year the bottom water temperatures were unusually high in the Davis Strait, the Disko Bay, and in several fjords. It is therefore likely that in 1966 large quantities of big shrimps had been transported into Disko Bay from the Davis Strait with the intruding warm bottom water.

Thus the offshore stocks must be regarded as important for the inshore stocks in two ways, namely by larval drift in the upper water layers and by intrusion of adults in the deep water layers.

III. DEVELOPMENT OF THE PANDALUS FISHERY AT GREENLAND

The Greenland shrimp fishery was started on a small scale in 1935 at Holsteinsborg, but was interrupted during the war. After 1950 it expanded rapidly, as many new and rich grounds had been found just after the war. It is mainly an inshore fishery, and the richest exploited grounds are in the Disko Bay area in depths mostly of 300-400 m, where by far the largest Greenland catches have been made. In recent years an offshore fishery has been developing in the Davis Strait in depths down to about 500 m.

About 130 boats are engaged in the inshore shrimp fishery, permanently or part of the year. Most of them are small side trawlers ranging from 15 to 25 GRT, although several reach 50 GRT. - On the offshore grounds bigger vessels are used, and in the latest years The Royal Greenland Trade Department (KGH) has occasionally used some of its big stern trawlers in this fishery.

In recent years other nations have developed a Pandalus fishery in the Davis Strait to such a large scale that in 1975 it is likely to have resulted in catches higher than the Greenlanders' catch of about 10 000 tons. A stock assessment is, therefore, highly actual as the shrimp resource is of vital interest to the Greenlanders.

The development of the Greenlanders' Pandalus fishery is shown in Table 1. In 1974 79% of their catches were taken in the Disko Bay and in 1975 70% were taken there.

TABLE 1. Annual landings from the Greenlanders' Pandalus fishery since 1950 (the 1975 figure is preliminary).

YEAR	METRIC TONS	YEAR	METRIC TONS
1950	175	1971	8 941
1955	566	1972	7 368
1960	1 789	1973	8 135
1965	5 051	1974	10 323
1970	8 429	1975	(9 885)

The development of the Pandalus fishery (all nations) at West Greenland since 1970 is shown in Table 2, and it is seen that in the last three years the development has been explosive.

TABLE 2. Annual landings by all nations from their Pandalus fishery at Greenland (the 1974-75 figures are preliminary and incomplete).

YEAR	1970	1971	1972	1973	1974	1975
GREENLAND	8 429	8 941	7 368	8 135	10 243	9 885
THE FAROES	130	496	755	1 371	2 023	5 300
DENMARK-M	-	-	-	196	308	c.1 000
NORWAY	-	-	1 409	2 940	5 616	>5 500
OTHER NATIONS	-	-	-	-	-	>3 000
TOTAL	8 559	9 437	9 532	12 642	18 190	>24 685

IV. THE PANDALUS FISHERY AT GREENLAND COMPARED WITH OTHER PANDALUS FISHERIES

The Pandalus fisheries have developed rapidly on all North Atlantic stocks after World War II. A description of the fisheries from various ICES countries up to 1970 has been given by Smidt (1971), and in Table 3 are shown the landings from the various ICNAF and ICES Subareas in the year 1970 to 1974.

TABLE 3. Annual landings (metric tons) from various ICNAF and ICES Subareas in the years 1970-1974.

YEAR	1970	1971	1972	1973	1974
ICNAF Subareas:					
1. WEST GREENLAND	8 559	9 437	9 532	12 642	18 492
4. CANADA	2 026	1 780	1 353	2 172	3 609
5. USA(Gulf of Maine)	10 615	11 127	11 016	9 339	7 964
ICES Subareas:					
I. Barents Sea	2 115	2 278	2 984	1 647	1 347 x)
IIa. Norwegian Sea	3 103	2 548	2 719	2 818	4 531
IIb. Spitzbergen and Bear Isl.	290	316	1 069	2 460	3 122
IIIa and IV Skagerrak and North Sea	9 160	10 440	8 776	6 572	5 250
Va. Iceland	4 510	6 326	5 291	7 286	6 515

x) Incl. algae from USSR catches

Of special interest for the problems in Greenland is the development of the USA fisheries in the Gulf of Maine. A rapid increase in annual landings in the 1960ies was followed by a drastic decline in the 1970ies as shown in Table 4.

TABLE 4. Annual USA Pandalus landings in metric tons from ICNAF Subarea 5 in the years 1960-1974.

YEAR	METRIC TONS	YEAR	METRIC TONS	YEAR	METRIC TONS
1960	40	1965	949	1970	10 615
1961	30	1966	1 748	1971	11 127
1962	176	1967	3 151	1972	11 008
1963	254	1968	6 567	1973	9 706
1964	422	1969	12 766	1974	7 964

The rapid rise and decline of the USA shrimp fisheries in Gulf of Maine is a serious warning to the fishery at Greenland. - R.L.Wigley (1975) gives the following comment to the situation in Gulf of Maine: "Assessments of the abundance of northern shrimp in the Gulf of Maine were conducted in 1974 and revealed that the population declined about 50 per cent from 1972 to 1975. Recruitment has steadily declined since 1969, and fishing mortality has probably been in excess of 1.5 since 1970".

Alaska (USA) has developed an important shrimp fishery (mainly on *Pandalus borealis*) in Northeastern Pacific (Gulland 1970 and FAO Yearbook of Fishery Statistics). Very big catches have been taken in the later years as seen in Table 5. Annual catches much bigger than in the ICNAF Subarea 1 are taken, but it should also be taken into consideration that the Northeastern Pacific area is much larger than ICNAF Subarea 1.

TABLE 5. Annual USA shrimp catches in the Northeastern Pacific (FAO Fishing Area 67).

YEAR	1965	1966	1967	1968	1969	1970	1971	1972	1973
METRIC TONS	8 800	15 300	24 500	25 000	27 800	40 900	48 000	47 500	65 100

In 1973-75 the average annual catch was about 46 000 metric tons (information from State of Alaska, Department of Fish and Game). Possibly the Alaskan catches have reached their highest level in 1973.

V. PROTECTIVE MEASURES TO BE TAKEN INTO CONSIDERATION

The actual fishery situation in Greenland water raises the question of precautionary regulation of the shrimp fishery there. The following measures can be taken into consideration: 1. Mesh size regulation. - 2. Protection of nursery grounds. - 3. Regulation of the fishery by a TAC as proposed in this paper.

1. Mesh size regulation

In order to find suitable measures to avoid catching small sized shrimps, some fishing experiments with different mesh sizes in the cod-end of the trawl but not with covered cod-end were made in 1964 in Disko Bay on three different fishing grounds. In six hauls (1 hour each) a mesh size of 20 mm (from knot to knot) was used, in three hauls 24 mm, and in five hauls 28 mm. The result was that when 100 kg were fished by nets with 20 mm meshes, 67 kg were fished with 24 mm meshes, and only 29 kg with 28 mm meshes (see Fig.2).

The selectivity by the differnt mesh sizes is shown in Table 6 and in Fig.2 where shrimps over 6 g (suitable for hand peeling), from 3 to 6 g (mostly for machine peeling), and under 3 g (discarded) are separated by weight. It is seen that 28 mm meshes avoid practically all undersized shrimps, but the catches are so small that this mesh size must be regarded as unsuitable. Also 24 mm meshes give much reduced catches compared with 20 mm meshes without giving noticeably better protection of the undersized shrimps. Therefore 20 to 22 mm mesh sizes, which are the mesh sizes actually used by several fishermen in Greenland must be regarded as appropriate, whereas the 18 mm mesh size used by other fishermen seems to be too small.

TABLE 6. Selectivity by different mesh sizes. The size groups given in percentages by weight.

Size group of shrimps	Mesh size in mm (knot to knot) 20	24	28
over 6 g	68%	75%	89%
3-6 g	26	20	10
under 3 g	6	5	1

Mesh size experiments with a shrimp trawl with covered cod-end were carried out by R/V DANA in the North Sea in 1973. With a mesh size of 14 mm (from knot to knot) in the cod-end the 50% retention length, l_c, was determined to 16 mm carapace length (Munch-Petersen 1973). A rough estimate then gives the following 50% retention lengths by various cod-ends:

18 mm meshes - l_c 20.6 mm carapace length
20 " " " 22.9 " " "
22 " " " 25.2 " " "

Norwegian mesh selection experiments have been carried out since 1968 by the alternative haul method and by using covered cod-end (Thomassen and Ulltang 1975). When 40 mm meshes (stretched) were used the 50% retention length ranged from 19.0 to 21.0 mm carapace length.

All these figures thus indicate mesh sizes from 20 to 22 mm (from knot to knot) to be appropriate in Greenland waters. This is also in good accordance with selection studies carried out in the Gulf of Maine. Wigley (1975) writes: "Mesh selection studies in 1974 resulted in the establishment of mesh regulation. The basic provision of this regulation stipulates that mesh size, in both the body and cod-end, of nets used for catching shrimps must be 1 3/4 inches (stretched measure) or larger. Major purpose of this regulation is to reduce the mortality of small shrimps". - This mesh size is the same as 44 mm stretched or 22 mm from knot to knot.

2. Protection of nursery grounds

There is normally some difference between the distribution of old and young shrimps. Catches from big depths are generally dominated by larger shrimps than catches from shallower depths (Horsted and Smidt 1956, pp 44, 94, 96). Many small sized shrimps are discarded from catches taken in shallower areas, and therefore a possible protective measure could be the closure of such nursery areas from commercial fishing.

The local Greenland shrimp fishery regulates itself to some extent due to a price differentiation. Lower prices of small sized shrimps than of big sized normally prevent the shrimp trawlers from fishing on grounds where small shrimps are dominating.

In the offshore areas our knowledge is not yet sufficient as to locate special nursery grounds. However, it is known that several offshore trawlers avoid grounds with small shrimps.

3. Regulation of the fishery by a TAC

The offshore fishery for Pandalus at the west coast of Greenland is - as described above - a young fishery, and till now only few catch/effort data have been available. The methods normally applied in fish and shrimp stock assessments can, therefore, not at present be applied to this fishery. In order to arrive at a precautionary TAC for the shrimp resources a method based on the present catch per area unit in the Disko Bay has been considered; This method and results obtained from its use will be described and discussed in the following.

The basic assumption underlying the method used is, that a precautionary TAC for the offshore shrimp fishing grounds should allow an exploitation in annual catch per unit area not extending that obtained in recent years in the Disko Bay. A catch per unit area of the Disko Bay-order should, however, be allowed only if the offshore fishing grounds are surrounded by non-exploited areas with Pandalus shrimps, so that there might be a supply of shrimps from non-exploited to exploited areas of at least the same magnitude as it is supposed for the Disko Bay.

In Fig.3 are shown the total landings of shrimps to the industries of the Royal Greenland Trade Department in the Disko Bay, practically equal to the total fishery in the Bay. The fishery in the Disko Bay did in 1974 yield a total of 8 000 metric tons of shrimps; in 1975 there has been a decrease in the landings of about 15%, partly due to the bad weather conditions in the beginning of the year compared to favourable conditions in the same period of 1974. However, also a general decline in catch per hour trawled has been reported. It is, therefore, the general impression, that the present annual catch in the Disko Bay is close to the MSY for this area. The annual catch per sq.km here in 1974 has, therefore, been chosen as a reasonable precautious maximum allowable annual catch per sq.km on the offshore fishing grounds, although some fishermen feel that the present catch rate in the Disko Bay may be in excess of the long-term catch by present effort.

In the Disko Bay the fishing grounds exploited in 1974 made up about 2 000 sq.km. It is however known, that the shrimps occur everywhere in the Bay in suitable depths, and the possibility of continued heavy fishing on the grounds is closely related with the possibility of supply of shrimps from the areas surrounding the fishing grounds. This is confirmed by the fact that the catch per hour trawled may decline to very low numbers on some fishing grounds following an intense fishery, forcing the cutters to move to other fishing grounds; after some time the cutters may return and find that the catches have risen again.

The areas supplying the fishing grounds - in the following referred to by 'supplying areas' - in the Disko Bay are estimated to total about 6 000 sq.km. In Fig.6 is shown the total extent of fishing grounds and supplying areas. The offshore shrimp fishing grounds Nos. II and III shown in the same figure are - as described earlier in this paper - supposed to be of great significance for the shrimp resources in the Disko Bay supplying them with shrimp larvae and possibly adult shrimps also, but are not included in the 6 000 sq.km supplying areas. On the other hand these do include the Vaigat northeast of Disko Island, an area supplying some smaller shrimp fishing grounds in the Vaigat and at the northwest entrance to this, catches from which are included in the Disko Bay catch figures. The Vaigat is, however, assumed not to be of significance for the shrimp fishing grounds in the Disko Bay proper, as northwest going currents predominates in the Vaigat.

Using a shrimp fishing ground area of 2 000 sq.km and a supplying area of 6 000 sq.km the ratio fishing ground/supplying areas is 1:3 for the Disko Bay shrimp resources. Using the total annual landings in 1974 as basis the yield per area unit would thus be 4 tons per sq.km fishing ground, or 1 ton per sq.km of the distribution area of the exploited shrimps.

These are the figures here used to calculate the total allowable catches on the offshore shrimp fishing grounds. When an offshore ground is surrounded by a supplying area as defined above, estimated to be located in a geographical position that will allow a reasonable migration of shrimps to the fishing ground, an annual catch of 4 metric tons of shrimps per sq.km is proposed as TAC. When the supplying area is absent, or it is estimated to be located in a geographical position in relation to the fishing ground that will not allow a migration of a reasonable size, the proposed annual TAC is reduced to 1 metric ton of shrimps per sq.km fishing ground. In both cases the proposed TAC can be expressed as 1 metric ton of shrimps per sq.km of the total distribution area of the exploited shrimps, including in the first case the supplying area in the total distribution area.

In Figures 4-10 is shown the known distribution of the offshore shrimp fishing grounds at the west coast of Greenland, based partly on experience gained during experimental fishery or by echo-sounding surveys of the Greenland Fisheries Investigations, partly on information received from some trawlers participating in the fishery in 1974-75. The areas included do not in all cases consist only of a bottom where bottom trawling is possible. This is especially true for the western part of fishing ground No.IV. A large scale fishery took place here in 1974, but the fishing was made on local concentrations of shrimps, the location of which is not known to GF.

The fishing grounds shown do not intend to enclose all possible trawling areas for shrimps at the west coast of Greenland. The occurrence of shrimps has been reported all way along the coast on the slope of the continental shelf in depths between 200 and 5-600 meters. These areas, however, are in some cases supposed to be supplying areas to the shown fishing grounds, in other cases the bottom is too rough for bottom trawling, or the conditions are unknown and the areas are not included in the calculation of a precautious TAC.

Fishing grounds Nos. I, VII, VIII, X, and XI are all considered to be surrounded by sufficient supplying areas, so that an annual catch of 4 tons of shrimps may be taken from these grounds. In the case of fishing grounds Nos. II, III, IV, V, and VI supplying areas are supposed not to be present or at least not with an area of sufficient size or in a geographical position that would make possible a migration of significance to the fishing grounds. In some cases - grounds Nos. II, III, and IV - the supplying areas are actually included in the fishing grounds shown. Therefore in all these cases the total allowable catch proposed has been reduced to 1 ton of shrimps per sq.km annually.

However - as fishing grounds Nos. II and III are supposed to be of great significance for the shrimp stocks in the Disko Bay by supplying these with shrimp larvae and sometimes also adult shrimps (as described earlier in this paper), the proposed total allowable catch per sq.km for these two fishing grounds has been reduced further to .5 ton annually.

The fishing ground No.IX (Ravns Dyb) has been excluded from the calculations, as the bottom seems too rough for bottom trawling with the gears used in the present fishery.

In Table 7 are given the estimated areas in sq.km of all the known fishing grounds in open water at the west coast of Greenland, and an annual TAC is calculated using the allowable catch per sq.km as stated above. The proposed total annual TAC for the offshore shrimp fisheries at the west coast of Greenland is about 26 000 tons.

VI. DISCUSSION

The explosive development in the offshore shrimp fishery at the west coast of Greenland stresses the need for a regulation of the fishery to protect the shrimp resources from overexploitation.

Three different types of protective measures have been considered in this paper. Mesh size regulations and closing of nursery grounds for the fishery would be valuable parts of a protection of the shrimp resources, but are, however, not considered to be sufficient alone, first of all because there is a need for an immediate effective regulation, which can only be realized by the introduction of a precautionary TAC for the fishery, but also because the present knowledge of the location of nursery grounds for the offshore shrimp stocks is restricted.

The method used in this paper to calculate a precautionary TAC for the offshore fishery is based on a number of assumptions, of which some may be quite questionable. The fishing grounds in the Disko Bay are fairly well known, so the 1974 catch per sq.km here is considered reliable. However, the extent of supplying areas necessary for an exploitation of the present size is not well known and are for the Disko Bay rather estimated too small than too large, keeping in mind the very likely supply of shrimp larvae from the offshore areas to the Disko Bay. If this is true, the proposed requirements for supplying areas for the offshore fishing grounds may be too small and the possible long term yield may be estimated too big. Recent years' very large offshore catches may be explained by the fact, that this fishery is performed in a virgin area, probably exploiting several accumulated year classes, where in the long run only the production of one year class should be exploited.

Another weakness of the method used is that the Disko Bay catches are used to estimate the possible yield on all the offshore grounds, but significant differences between the northern and southern parts of the exploited offshore grounds are likely. The difference in development time of the shrimps between northern and southern parts of the west coast of Greenland has already been described.

The extent of the offshore fishing grounds used in the calculation of TAC are based on the present knowledge and may be changed significantly in the coming years, also depending on the development of gears used in the fishery. The proposed TACs are strictly tied to individual fishing grounds. Extensions of the exploited areas should, however, not automatically lead to higher allowed catches than proposed in this paper until evidence is given that the extensions are not interferring with the supplying areas supposed in this paper. For instance information from Faeroese fishermen has already confirmed that the present fishery is exploiting areas larger than those used in the calculation of the TACs for fishing grounds Nos. VII, VIII, and X.

As stated in Res.Doc. /75 the Faeroese fishermen exploites areas of about four times the size of the areas used in this paper, but these extensions very closely cover the areas supposed as supplying areas for the fishing grounds, and they should therefore not influence the proposed TACs.

The catch figures given for the Disko Bay fisheries are based on the landings, but are very close to the actual catches as practically all of the catch is landed and discards take place from the shrimp industries. Considering the offshore fisheries the landings are minimum estimates of the total catches, as from 0 up to 80% of the catch is known to be discarded, depending on the type of precessing of the shrimps performed on the vessel. As the TAC proposed in this paper are calculated based on Disko Bay catch figures, they should cover the total catches in the offshore fisheries. Also for this reason better catch statistics including discards should be collected from the offshore fisheries.

The proposed TACs of this paper are - based on the Disko Bay fishery in 1974 - considered valid for the near future only, and new data in the coming year are hoped to make possible evaluations of the total allowable catch on a more sound basis. Also the possible connection between the decline of the cod stock at West Greenland, the cod being an important predator to the shrimps, and the present size of the shrimp resource in the same area should be kept in mind. The development in the stocks of cod and other possible predators for the shrimp should, therefore, be followed closely and may influence the calculations of future TACs.

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TABLE 7 Areas of known open water shrimp fishing grounds (sq.km) and total annual TACs calculated from proposed annual TAC per sq.km (metric tons).

FISHING GROUND NO.	LOCALITY	AREA in sq.km	PROPOSED ANNUAL TAC per sq.km (metric tons)	TOTAL ANNUAL TAC (metric tons)
I	Nordostbugten (Mermaid Ground)	1 500	4	6 000
II	West of Blåfjeld	4 000	.5	2 000
III	North of Store Helle-fiskebanke	9 800	.5	4 900
IV	West of Store Helle-fiskebanke and Holsteinsborg Dyb	8 000	1	8 000
V	Sukkertoppen Dyb	2 300	1	2 300
VI	Godthåb Dyb	900	1	900
VII	Fiskenæs Dyb	180	4	720
VIII	Danas Dyb	80	4	320
(IX	Ravns Dyb[x)])			
X	Frederikshåb Dyb	125	4	500
XI	Julianehåbsbugten	60	4	240
TOTAL annual TAC for all fishing grounds, metric tons				25 880

[x)] Regarding exclusion of Ravns Dyb from the calculations: See explanation in the text.

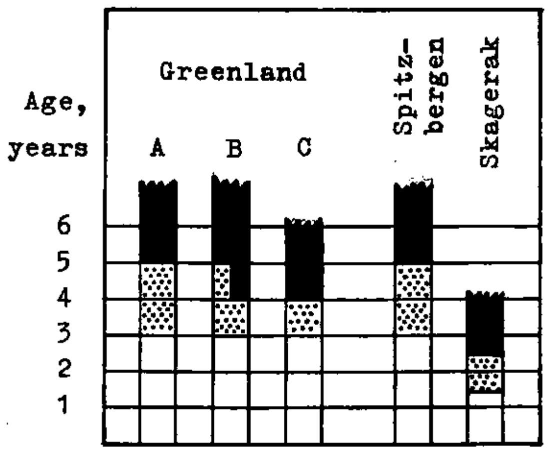

Fig. 1. Variation in development time of Pandalus borealis at Greenland (A, B, C) compared to other areas. 1 - 6 indicate years. White sections of columns indicate juveniles, dotted sections indicate males, and black sections indicate females.

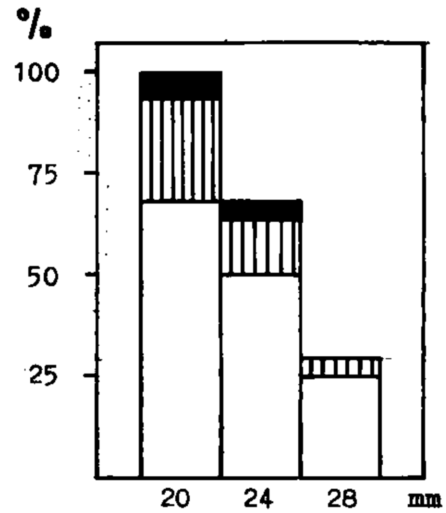

Fig. 2. Relative variation by weight in shrimp catches from Disko Bay by various mesh sizes (20, 24 and 28 mm from knot to knot) in the trawl cod-end. White sections of columns indicate shrimps over 6 g, stribed sections indicate shrimps between 3 and 6 g, and black sections indicate shrimps under 3 g (discard).

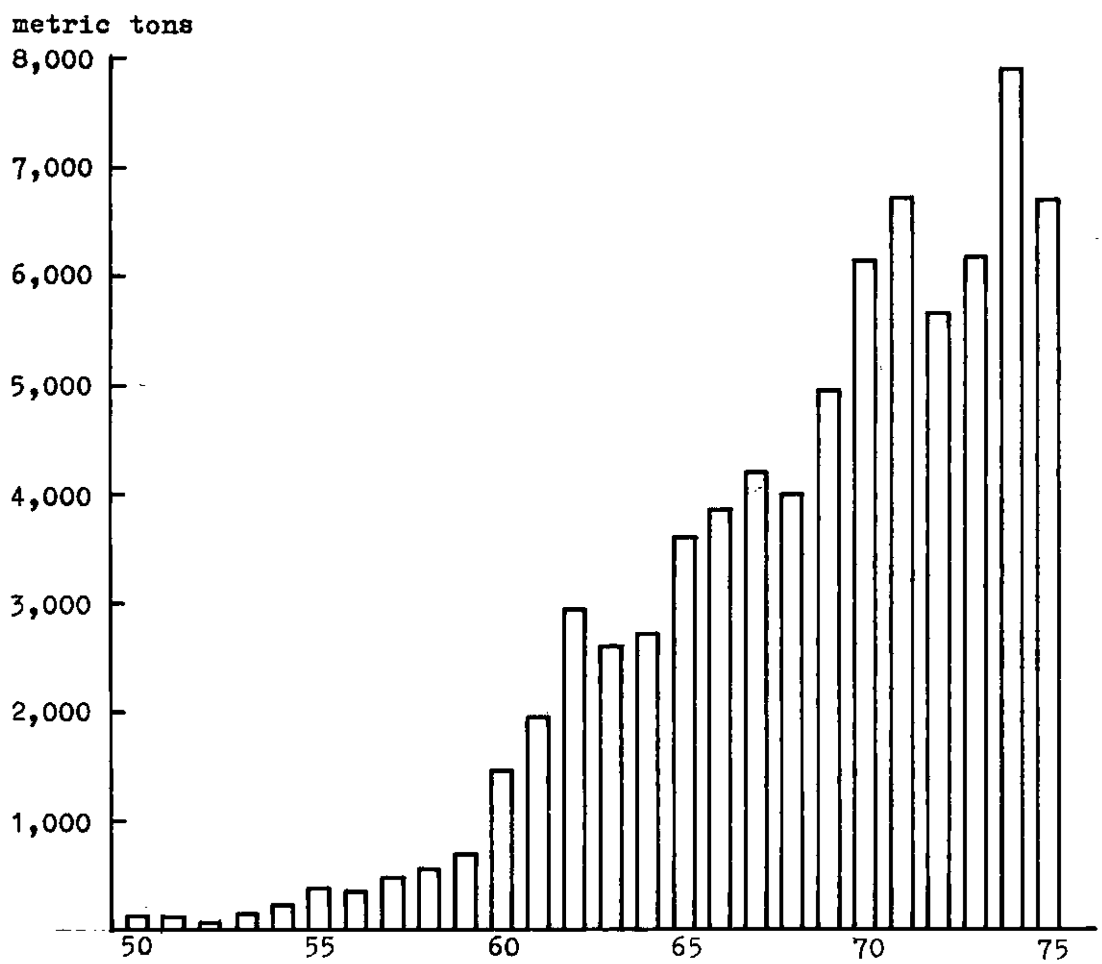

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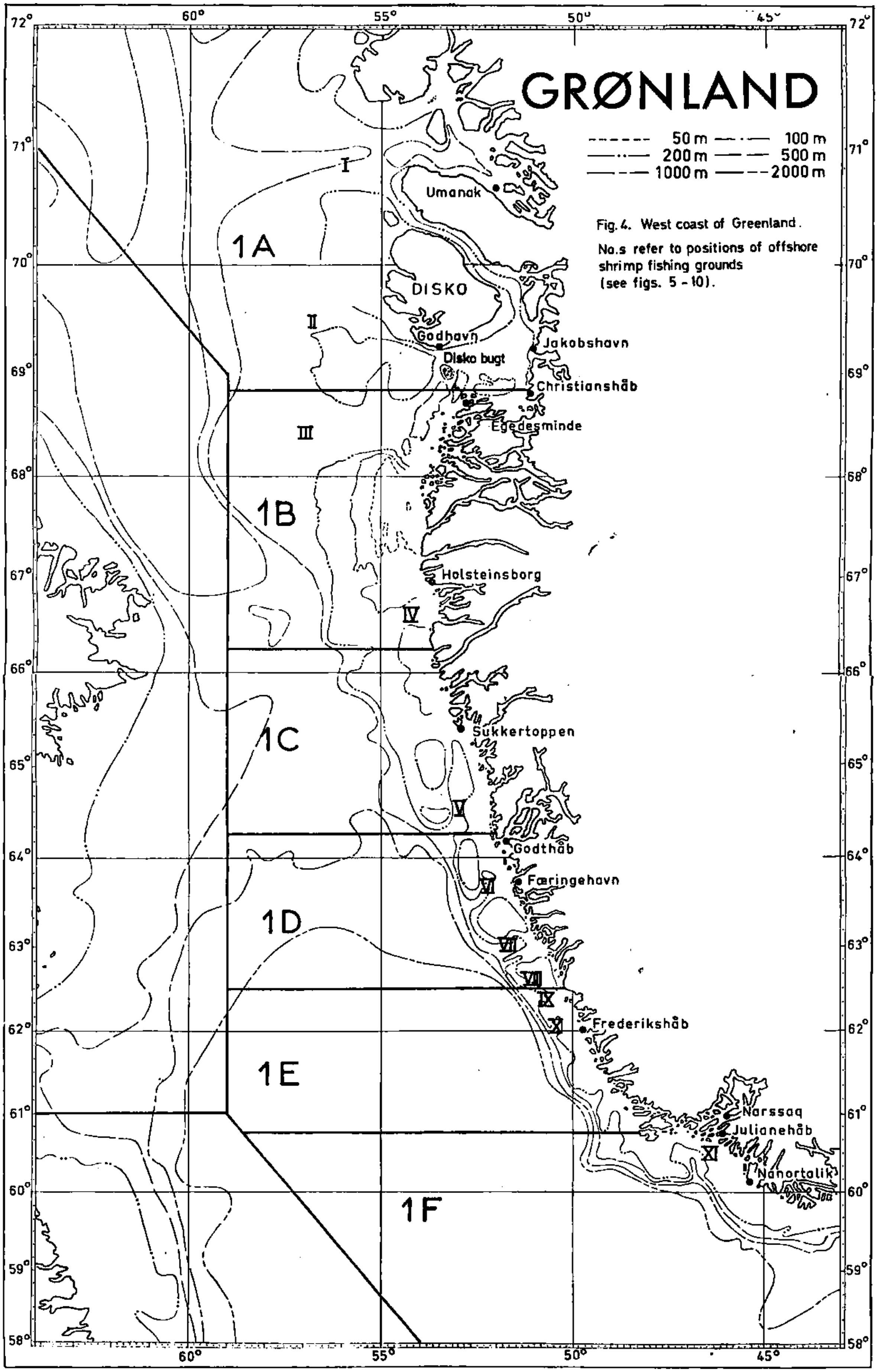
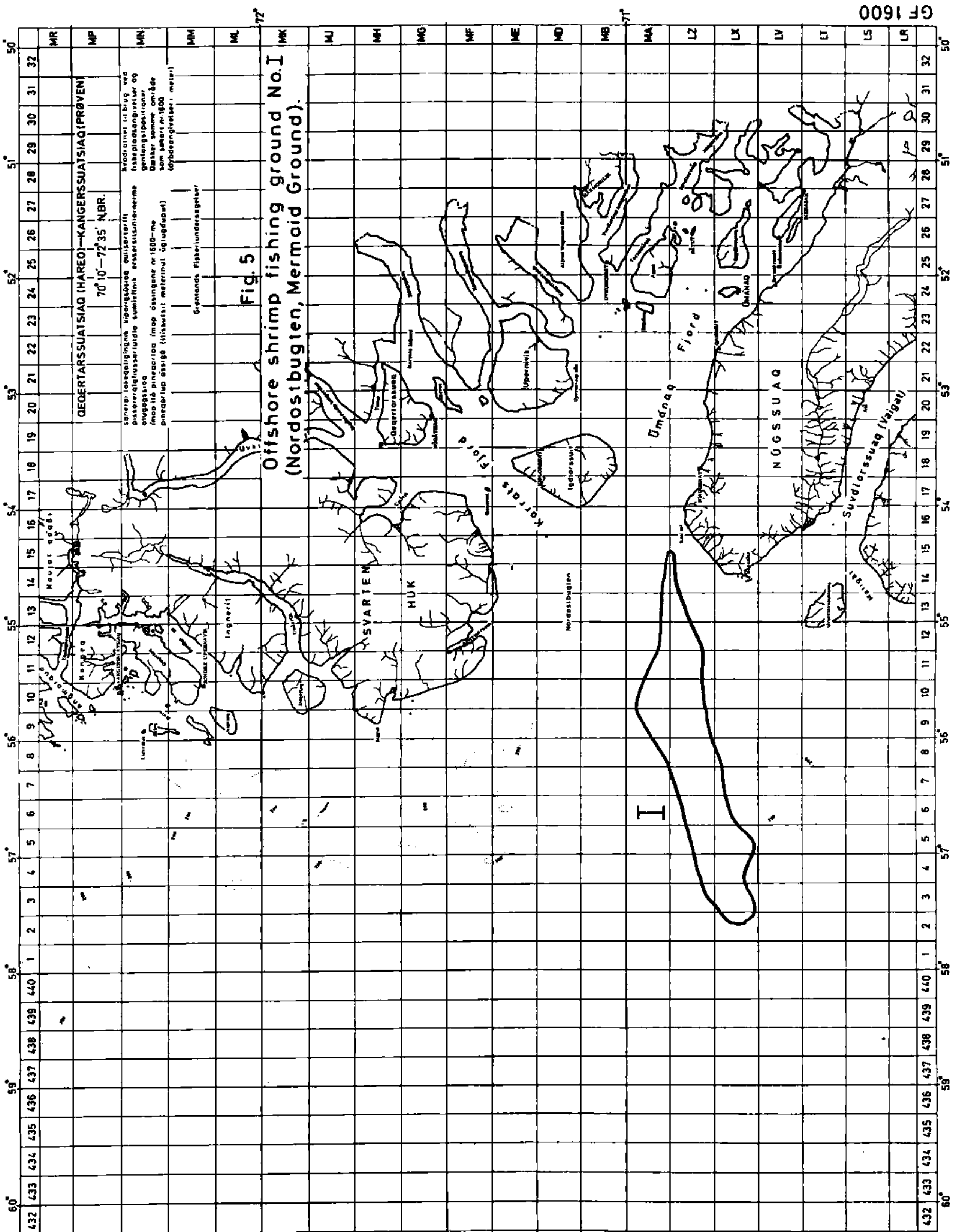
Fig. 3. Total landings of shrimps to the shrimp industries of the Royal Greenland Trade Department in the Disko Bay 1950-1975.


GRØNLAND
50 m
100 m
200 m
500 m
1000 m
2000 m
Fig. 4. West coast of Greenland.
No.s refer to positions of offshore shrimp fishing grounds (see figs. 5 - 10).
Umanak
DISKO
Godhavn
Disko bugt
Jakobshavn
Christianshåb
Egedesminde
Holsteinsborg
Sukkertoppen
Godthåb
Færingehavn
Frederikshåb
Narssaq
Julianehåb
Nanortalik
1A
1B
1C
1D
1E
1F
I
II
III
IV
V
VI
VII
VIII
IX
X
XI
72°
71°
70°
69°
68°
67°
66°
65°
64°
63°
62°
61°
60°
59°
58°
60°
55°
50°
45°

B 1


GF 1600
QEQERTARSSUATSIAQ (HAREØ)—KANGERSSUATSIAQ (PRØVEN)
70°10'—72°35' N.BR.
Fig. 5
Offshore shrimp fishing ground No. I
(Nordostbugten, Mermaid Ground).
SVARTENHUK
Ingnerit
Karrats Fjord
Nordostbugten
Ûmánaq Fjord
NÛGSSUAQ
Suvdlorssuaq (Vaigat)
I
GF 1600

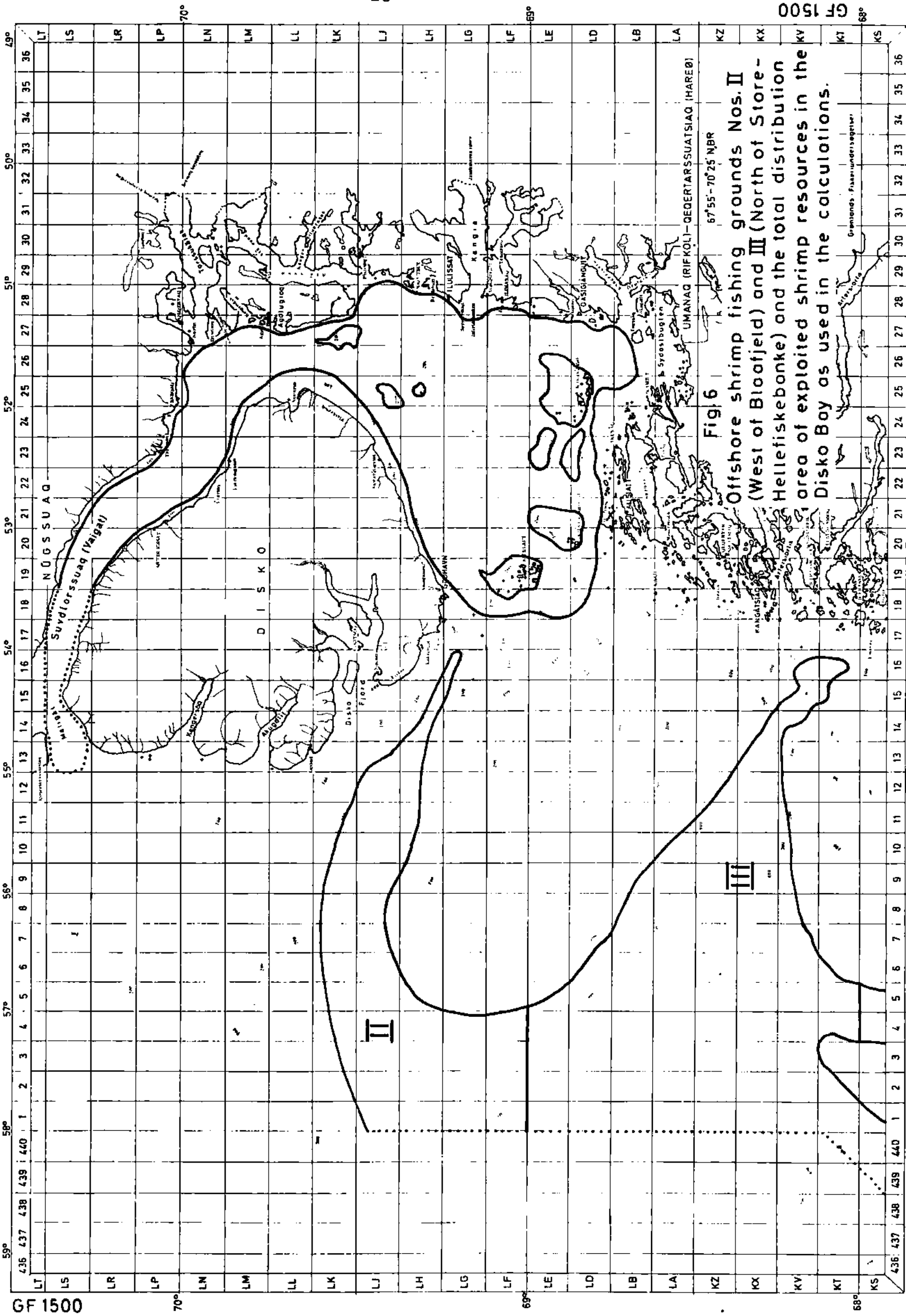


Fig. 6
Offshore shrimp fishing grounds Nos. II (West of Blaafjeld) and III (North of Store-Hellefiskebanke) and the total distribution area of exploited shrimp resources in the Disko Bay as used in the calculations.

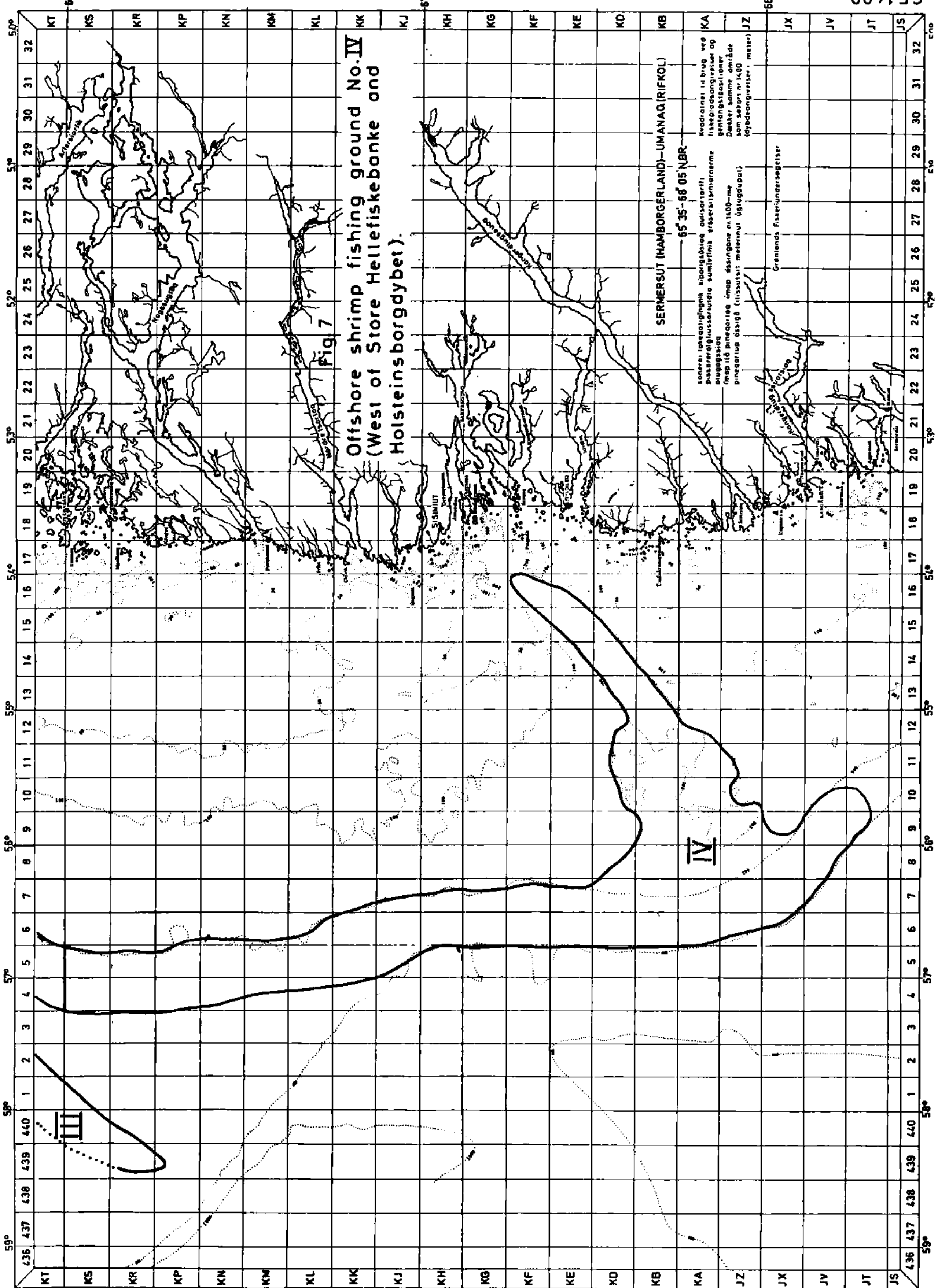


Fig. 7

Offshore shrimp fishing ground No. IV (West of Store Hellefiskebanke and Holsteinsborgdybet).

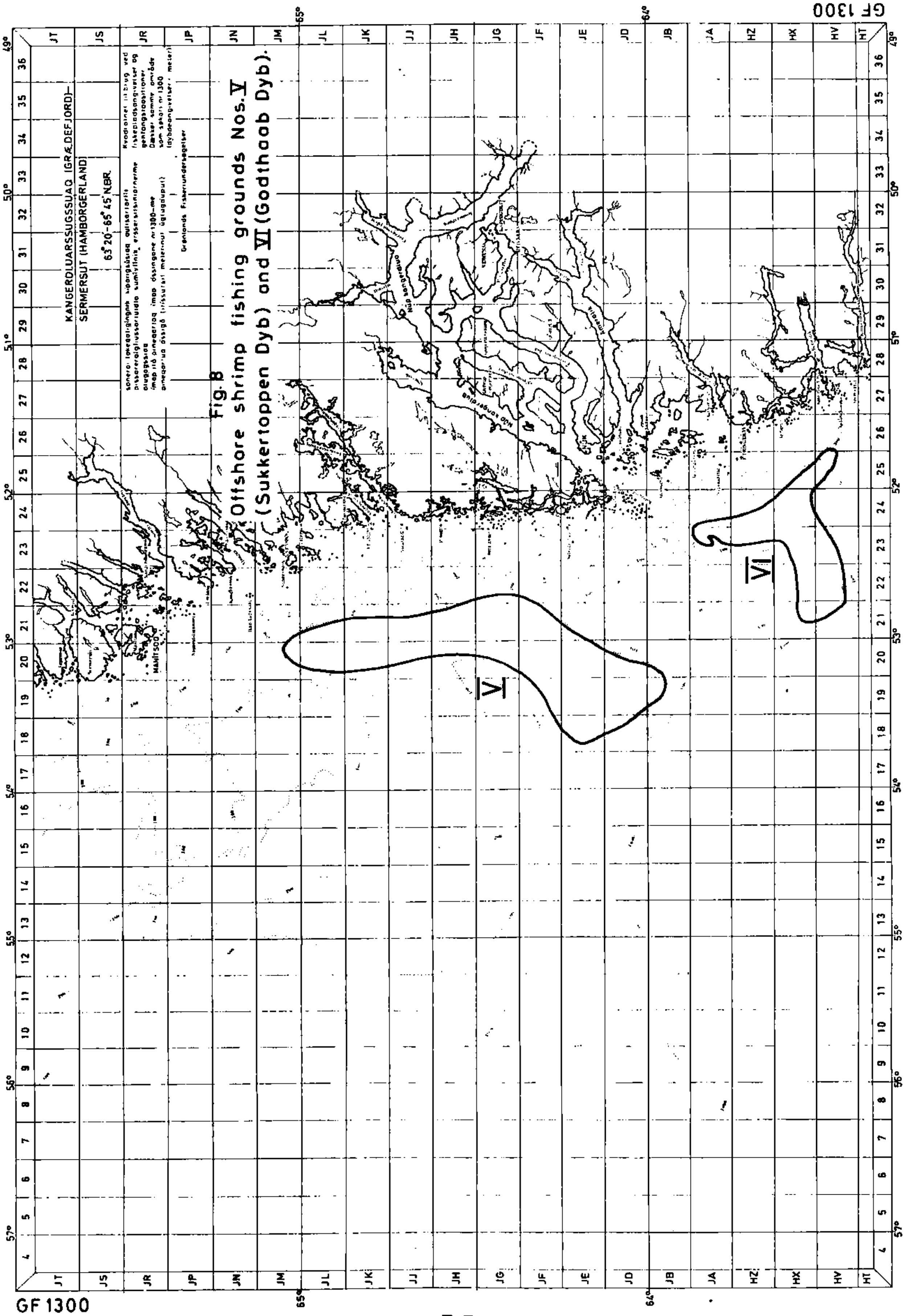


Fig. 8
Offshore shrimp fishing grounds Nos. V (Sukkertoppen Dyb) and VI (Godthaab Dyb).

B 5

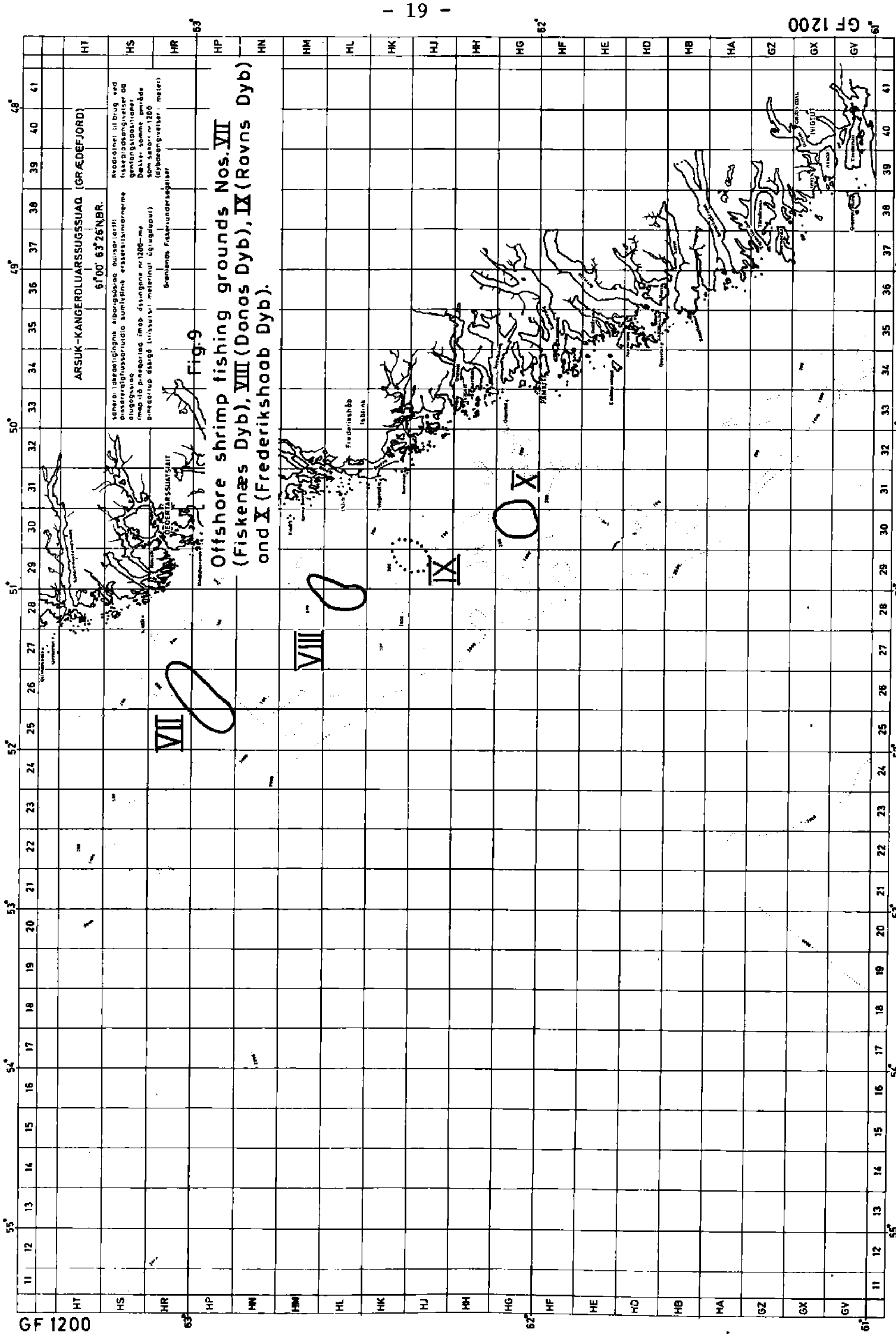


Fig. 9
Offshore shrimp fishing grounds Nos. VII (Fiskenæs Dyb), VIII (Danas Dyb), IX (Ravns Dyb) and X (Frederikshaab Dyb).

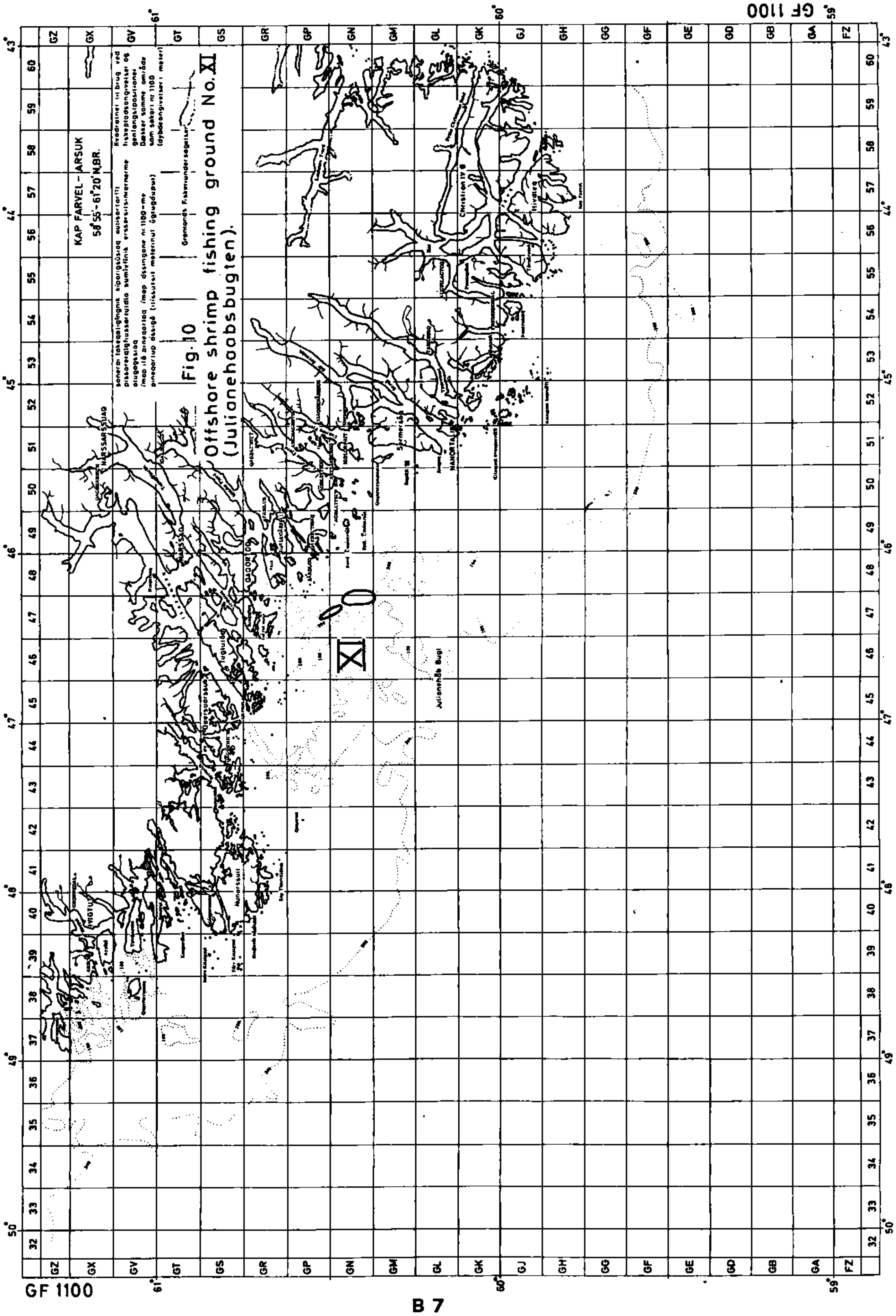


Fig. 10 Offshore shrimp fishing ground No. XI (Julianehaabsbugten).