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A TRAWL SURVEY OF THE OFFSHORE SHRIMP GROUNDS OF ICNAF DIV. 1B AND AN ESTIMATE OF THE SHRIMP BIOMASS

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INTRODUCTION

Research surveys of the offshore grounds for shrimp fishing at West Greenland have shown that the most extensive grounds are found in ICNAF Divs. 1A and 1B (Carlsson and Smidt, 1976). Catch statistics as well as some ICNAF research documents (Hoydal, 1976, Berenboim et al.,1976, Fuertes and Lopez Veiga,1976) clearly show that in 1975 by far the greatest effort was found in Div.1B. The same seems to be the case in 1976 according to various observations. The research work of 1976 has, therefore, been concentrated in this important area.

As part of the work a trawl survey was made in July 1976 by the Greenland trawler SISIMIUT, kindly placed at the disposal of the Greenland fisheries research institute by the Royal Greenland Trade Department. This trawler has itself been engaged in shrimp fishing in some of the months of 1976, so that gear, vessel and experience of the captain and crew can be considered professional. The author and one technician participated in the survey.

MATERIAL AND METHODS

The area covered by the survey extends from 66° to 69°N lat. and as far west as the 600 m contour line although not west of 59°W long., where drift ice made fishing impossible, Figs. 1 and 2.

Inside this area a number of stations were selected before the survey started, placed at various parts of the grounds. The distribution of stations was made so as to cover various depths and various latitudes. The pre-selected positions did in all cases correspond extremely well with the expected depths (a map with 10 m curves supplied by the Geological Survey of Greenland was used to select stations), and the professional gear allowed trawling on most bottom types. Only in few cases was the bottom as occurring on the echo sounder considered too risky for trawling, but trawling possibilities in the desired depth was then normally found close to the pre-selected position. Some desired stations west of 59°W long. between 68° and 69°N lat. could not be operated due to formations of drift ice.

At all stations one trawl haul was made, normally of one hour's duration. A list of the hauls is given in Table 1.

At each haul the catch was sorted and handled by the crew in the normal commercial way, and the fishing logbook was recorded as usual. The catch was recorded by the crew in units of boxes, one box equalling about 30 kg of shrimps. In each haul a sample of about 2 kg of shrimps was taken and frozen for later analyses (see Res.Doc. 76/XII/).By-catch of fish by species and of invertebrates other than Pandalus borealis was estimated by the two observers and in most cases samples for length frequencies were taken of redfish and Greenland halibut. The by-catch material is not yet worked up.

Based on the map mentioned above and on observations during the survey a stratification of the area covered by the survey has been attempted (Figs. 3 and 4). A more refined stratification can no doubt be made in due time, but as a preliminary stratification of the area it has been used here to estimate the biomass of shrimps inside each strata. The area of each strata, and the stations operated inside each strata are given in Table 2, the numbering of the stations also shown on Figs. 3 and 4.

Altogether 44 stations of the about 50 pre-desired stations were operated in the survey. Furthermore, a couple of days were set aside for the vessel to go fishing commercially at a place chosen by the captain. This commercial fishing was interrupted after one day due to the necessity of bringing a sick fisherman to Holsteinsborg, but 8 commercial hauls were made, centered in rectangles KK 5-6 (Figs. 2 and 4), where about 25 large otter trawlers of various nationalities were fishing at that time.

All hauls were converted to hauls of 1 hour's duration (most hauls were actually 1-hour hauls). Also, in order to take into consideration the diurnal variation in catches a conversion factor was applied, see later section.

Trawling took place by a speed of 3 knots. The gear was a "Fjortoft Sputnik" otter trawl, head line 43 m, ground rope 51 m. Hoydal (Res.Doc.76/VI/15) estimates that this gear covers a sector of 30 m width and thereby an area of 0.167 km^2 per hour's trawling by a speed of 3 nautical miles per hour. Fishermen and gear manufactures who were asked by the author consider this figure very likely. The same figure is, therefore, used in this document for the area swept by the trawl in one hour.

RESULTS

Diurnal variation. It was quite obvious from the results of the various hauls in the survey, that the variation in catch per hour between various depths and areas was considerable, and that this variation made it impossible to use the material for analyses of diurnal variation in catches. However, the eight commercial hauls and the commercial fishing conducted by the same vessel in the same division and month before and after the survey can be used to estimate the diurnal variation (see Smidt, Res.Doc. 76/XII/149). This commercial material is illustrated in Fig.5. The highest density (or availability) of shrimps on the bottom occurs early afternoon, whereas catch rates in the night are lower. Although considerable variation exist in the material it seems, nevertheless, clear that results will be biassed if the diurnal variation is neglected. Factors to convert hauls to top-point of the 24 hours are given in Table 3. If a haul extends into two of the 2-hours periods given in the table then a weighted mean conversion factor is used, weighting factor being the appropriate time inside each of the standard periods. Conversion factors applied to the survey hauls are given in Table 1.

Length composition of shrimp catches. This material is presented in Res. Doc. 76/XII/ by

Estimates of shrimp biomass. An estimate of the biomass can be obtained for each strata by assuming that the mean catch per hour, i.e. per 0.167 km^2, obtained on the stations inside the strata can be expected in all parts of the strata. The figures obtained for each strata are given in Table 2. As will be seen these figures add up to a total estimate of about 54 000 tons by July 1976. It is pointed out, that this figure corresponds only to that part of the biomass which is represented by the length groups in the catches, and no correction has been made due to possible selectivity between length groups. Also for other reasons mentioned below the figure for biomass is likely to be a minimum figure, anyway for the July 1976 biomass.

DISCUSSION

It has already been mentioned above that the method applied involves that the biomass given exclude such length groups which are not retained by the trawl, and no correction due to selectivity has been made. This will tend to underestimate the biomass. The method further assumes that all shrimps (of the proper length groups) found inside or above the area covered by the haul are actually caught by the trawl. Some shrimps may be found so far above the bottom that they escape the trawl, but the correction for diurnal variation does, at least to some extent, take care of this possibility. It is not known to what extent shrimps may actively escape from the target area just before the trawl reaches the shrimp or to what extent the rather heavy bobbins allow some shrimps to escape below the net. However, it seems more likely that some shrimps inside the area trawled escape rather than they are all caught. The fleet is most often concentrated in a very small area, say inside ten rectangles of the maps in Figs. 1-4, and if all shrimps were retained by each haul one would expect to see a rather steep decline in catches inside a short period. For example, an area corresponding to 10 rectangles (about 1500 km^2) would have been fished in about 9000 trawling hours, corresponding very roughly to 20-25 trawlers in about a month. Some shrimps would, as said, escape through diurnal migration, and the reduction in initial stock due to fishing may be compensated for by immigration from adjacent areas, but nevertheless one would expect to see a more pronounced tendency to a drop-off in catch rate when the fleet concentrates.

All these circumstances point to the likelihood of the biomass estimate being a minimum estimate.

Catch rates in the commercial fishery of the SISIMIUT through 1976 have generally been higher than the catch rates in the survey. This is, of course, primarily due to the fact that fishermen choose the best places for their fishing, but could to some extent also be due to difference in the length of the haul. Nearly all survey hauls were 1-hour hauls, reckoned from the minute that the easing off of trawlwire was stopped to the minute when the hauling started. No consideration was given to a possible time lag between the moment when the winch was stopped to the time when the trawl was actually on the bottom. Any minute of lag time would mean close to 1000 tons more in the total biomass

150

estimate, but the lag time is not supposed to be more than up to five minutes. No information exists as to whether the trawl gradually fish better as a catch accumulates.

The commercial shrimp fishery of the SISIMIUT in 1976 is shown in Table 4. Hauls have generally been of a duration of about two hours. The catch per hour is, therefore, fluctuating between some 300 and some 700 kg per hour, and this level corresponds rather well with the level of the better hauls in the survey cruise (Table 1). The difference between an abundance index obtained by a 1-hour haul as compared to that obtained by a longer haul does, therefore, not seem to be significant.

An estimate of the biomass does not by itself indicate the long-term yield from the biomass unless other factors such as biological parameters are known. Such other factors will be presented and discussed in other research documents, and the present document does not intend to lead up to a yield figure. However, some further points should be raised in the discussion of this paper which may influence the discussion of the possible yield.

Probably the most remarkable feature in the survey is the nearly complete absence of shrimps in some of the KB rectangles (Fig.2), so much the more noteworthy as these and some adjacent rectangles were fished by the SISIMIUT with rather good results earlier in the year (Table 4). It was also remarkable that catch rate during the commercial day (Table 5) was well above the level of most of the survey hauls although not of hauls close to the area, hauls Nos. 25, 26 and 27 in Table 1. A fleet of at least 25 large vessels was concentrated here at that time. The fleet seems to have moved northwards gradually through the fishing period of 1976 (Table 4).

In 1971 the R/V ADOLF JENSEN conducted a survey in part of the area covered by the SISIMIUT survey, covering the area between 66°N and 68°N and including 6 hauls on various depths. These hauls are given in Table 6. It will be seen that only one of the hauls gave a reasonable good catch. Although the depths fished at that time were generally greater than those in the areas now occupied by the commercial fleet the results of the two surveys show that great variation in shrimp abundance occur both between years, and inside years between months, and between areas. The same was experienced by the R/V DANA in the deep north of Store Hellefiskebanke where catches were good in 1964 but where an attempt to introduce the ground to Greenland fishermen in 1966 failed due to poor catches.

The experience in 1964 and 1966 is probably explained through hydrographical observations. The hydrographic situation off West Greenland in 1966 was characterized by unusually warm water west of the banks, and this warm current extended into the Disko Bay where bottom temperatures were about 3.5°C against a normal 2°C (Hansen, 1967a). Hansen (1967b) states that the shrimp catches in the Disko Bay were unusually high in 1966 and finds as a likely explanation that warm bottom currents have transported great quantities of shrimps from the Davis Strait grounds to the Disko Bay. Hermann (1967) shows that this warm current along the West Greenland coast could be followed from 1963 to 1966, when it culminated in Div. 1B and in the Disko Bay.

It should, therefore, be stressed not only that the biomass figure is a likely underestimate, but also that it applies only to the (July) 1976 situation. There is no guarantee that this biomass is a <u>standing</u> crop in the area.

Possibly currents of various temperatures keep the shrimp stocks in constant movement, sometimes distributed over a wide area, sometimes concentrated in more limited areas. Anyway, fishermen are likely to find the good concentrations, and it may, therefore, lead to overestimation of biomass (and yield) if straight commercial data are extrapolated to cover vast areas outside the limited area actually fished in any given short time.

ACKNOWLEDGEMENT

My most sincere thanks are due to the captain and crew of the SISIMIUT for their great help and good co-operation during the survey and to the Royal Greenland Trade Department for making it possible to use the vessel for this survey. Mr.K.P.Nielsen was a most effective technician aboard and my colleagues in the institute have been of great help in preparing and discussing the material for this document.

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TABLE 1. Catch of shrimps per hour on the stations of the SISIMIUT survey, 1976, corrected for diurnal variation in catches. (See Figs. 1-2 for position of stations).

St. No.	Date July	Time of hauling	Depth m	Catch per hour kg	Conversion factor applied	Catch per hour corrected
1	14	0015-0115	450	60	1.80	108
2	14	0240-0340	530	150	1.50	225
3	14	0715-0815	380	280	1.19	333
4	14	0950-1110	475	135	1.08	146
5	14	1305-1405	350	150	1.02	153
6	14	1545-1645	330	240	1.04	250
7	14	1815-1915	350-380	150	1.21	182
8	14	2135-2235	265	315	1.66	523
9	15	0135-0235	330	100	1.63	163
10	15	0540-0640	320	120	1.25	150
11	15	1210-1310	225	300	1.02	306
12	15	1400-1500	160	120	1.00	120
13	15	1600-1700	140-160	35	1.05	37
14	15	1845-1945	185-195	150	1.21	182
15	15	2110-2210	265	330	1.53	505
16	15-16	2345-0045	350-360	90	1.80	162
17	16	0205-0305	435	60	1.50	90
18	16	0405-0500	300-310	360	1.33	479
19	16	0630-0730	340-370	150	1.21	182
20	16	0940-1040	280-290	600	1.09	654
21	16	1215-1315	220	480	1.02	490
22	16	1510-1610	160-170	30	1.01	30
23	16	1740-1840	230	540	1.16	626
24	16	2115-2215	475	55	1.55	85
25	17	0015-0115	450-460	270	1.80	486
26	17	0215-0315	350	630	1.50	945
27	17	0500-0610	265	280	1.31	367
28	17	0700-0800	170	20	1.21	24
29	17	0905-1105	390-400	270	1.10	297
30	17	1220-1320	550	180	1.02	183
31	17	1410-1510	450	390	1.00	390
32	17	1555-1655	340-350	420	1.05	441
33	17	1735-1835	255	60	1.14	68
34	17	1910-2010	170-190	210	1.25	263
35	17	2100-2200	128-135	35	1.47	51
36-43	18	commercial fishing				
44	20	1500-1600	550	0	1.00	0
45	20	1650-1750	450	½	1.05	½
46	20	1830-1945	350	48	1.21	58
47	20	2020-2125	225	4	1.47	6
48	20	2200-2330	170	3	1.80	5
49	21	0045-0145	205-210	240	1.80	432
50	21	0350-0500	245-250	437	1.35	590
51	21	0545-0645	188-195	150	1.24	186
52	21	0750-0855	420	250	1.15	288

TABLE 2. Mean catch per hour, depth range, approximate area of stratas as shown in Figs. 3-4, and estimate of shrimp biomass inside each strata by July 1976.

Sample Nos.	Catch/hour (corrected)	Mean catch/hour kg	Depth range m	Area of strata km^2	Estimated biomass tons
8	523	523	200-300	2475	7751
3	333				
6	250				
7	182				
9	163				
10	150	215	300-400	7705	9920
1	108				
4	146				
17	90	115	400-500	3000	2066
2	225	225	500-550	355	478
5	153				
16	162				
19	182	166	300-400	2930	2912
18	479	479	250-300	515	1477
11	306				
15	505				
20	654				
21	490	489	200-300	3665	10731
12	120				
14	182	151	150-200	1615	1460
13	37	37	140-160	borderline	
22	30				
28	24	27	150-200	450	73
23	626				
27	367	497	200-300	1565	4658
24	85				
25	486	286	400-600	300	513
26	945	945	300-400	450	2546
30	183				
31	390	287	400-600	520	894
29	297				
32	441	369	300-400	520	1149
33	68	68	200-300	300	122
34	263	263	150-200	1270	2000
35	51	51	128-135	borderline	
44	0				
45	0.5	0.5	400-600	615	2
46	58	58	300-400	230	80
47	6	6	200-300	310	11
48	5	5	150-200	2470	74
49	432				
50	590	511	250-300	1155	3534
51	186	186	150-200	1545	1720
52	288	288	300-500	230	397
Total Area/Biomass				34.190	54.568

TABLE 4. The commercial shrimp fishery of the stern trawler SISIMIUT, 1976. Latitude given by rectangle codes, see Figs. 2 and 4. Each set of figures gives numbers of hauls - catch in hundreds of kilograms and catch (kg) per haul. Catch per haul not calculated unless at least 5 hauls are taken. Figures are preliminary as obtained through vessel's logbook where catches are estimated to nearest hundred kilograms. Duration of a haul on average close to two hours.

Lat.	27 Dec -15 Jan	16-31 Jan	1-15 Feb	16-31 May	1-15 Jun	16-30 Jun	1-15 Jul	16-31 Jul	1-15 Aug	16-31 Aug	1-15 Sep	16-30 Sep	1-15 Oct	16-31 Oct
KS													10-140 1400	7-47 671
KR													18-159 883	6-39 650
KP												23-329 1430	20-153 765	22-198 900
KN												40-419 1048	14-92 657	22-214 973
KM					7-110 1571	13-151 1162			105-1191 1134	139-1012 728	42-713 1698	18-188 1044	4-20 -	6-58 967
KL					18-246 1367	35-301 860		36-459 1525	24-252 1050	25-135 540	51-795 1559		3-7 -	1-2 -
KK					37-444 1200	29-256 883	4-40 -	43-358 833		2-2 -	1-2 -		5-16 320	
KJ					10-80 800	35-455 1300	74-633 855	68-510 750		6-23 383	1-2 -		3-29 -	
KH					8-55 688		51-321 629			4-29 -				
KG	4-7 -				9-65 722									
KF	5-15 300			6-33 550	15-103 687									
KE					45-207x) 460									
KD	1-1 -					18-142 789								
KB	15-136 907					11-76 691								
KA	17-161 947		2-4 -											
JZ	32-463 1447	60-748 1247	21-165 786											
JX														
JV	1-1 -													
Total	75-783 1044	60-748 1247	23-169 735	6-33 550	149-1310 879	141-1381 979	129-994 771	147-1327 903	129-1443 1119	176-1201 682	95-1512 1592	81-936 1156	77-616 800	64-558 872

x) Inner part of Holsteinsborg Deep.

Table 3. Conversion factors for diurnal variation of shrimp catches, July, Div. 1B.

Time of day (hrs.)	0-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	16-18	18-20	20-22	22-24
Catch (kg) per hour from Fig. 5	600	720	815	890	950	1010	1060	1080	1030	890	735	600
Conversion factor	1.80	1.50	1.33	1.21	1.14	1.07	1.02	1.00	1.05	1.21	1.47	1.80

Table 5 Commercial shrimp fishing by the SISIMIUT on 18 July 1976 in rectangles KK 5-6 (Figs. 2 and 4). Catches are preliminary estimates to nearest hundred kg as given in the vessel's logbook.

Time trawled	Total catch kg	Catch per hour	Diurnal conversion factor	Corrected catch per hour
0045 - 0150	400	369	1.80	664
0230 - 0435	2500	1200	1.45	1740
0505 - 0710	1800	864	1.26	1089
0745 - 0945	960	480	1.15	552
1045 - 1245	900	450	1.05	473
1320 - 1520	1000	500	1.01	505
1605 - 1805	1800	900	1.06	954
1830 - 1945	1000	800	1.21	968
Total 8 hauls 13 hrs.25 min.	10 360	weighted mean 773	-	weighted mean 882

Table 6 Catches of shrimp in trawl hauls made by the R/V ADOLF JENSEN, 1971 west of St. Hellefiskebanke.

Date	Rectangle No. (see Figs. 2 and 4)	Depth m	Time trawled	Catch of shrimp pr. hour.
24/7	JZ 5	670	1525 - 1628	7 specimens
4/8	KB 6	480	1522 - 1622	6 specimens
5/8	KG 6	530	0951 - 1015	4.8 kg
6/8	KK 6	300-340	1607 - 1707	38 kg
10/8	KP 438	350	1336 - 1436	112 kg
11/8	KL 3	500-570	1630 - 1730	2.5 kg

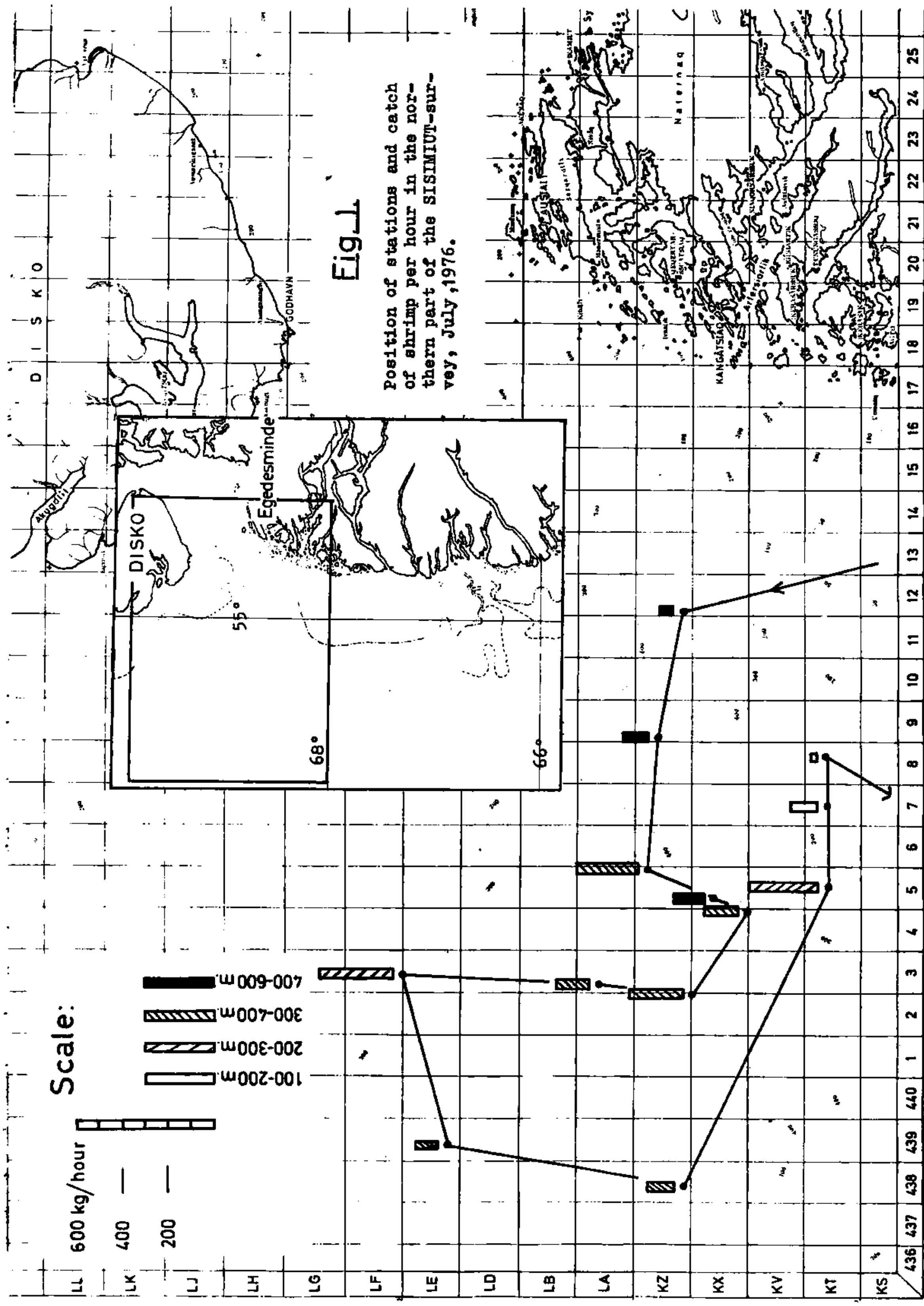

Fig. 1

Position of stations and catch of shrimp per hour in the northern part of the SISIMIUT-survey, July, 1976.

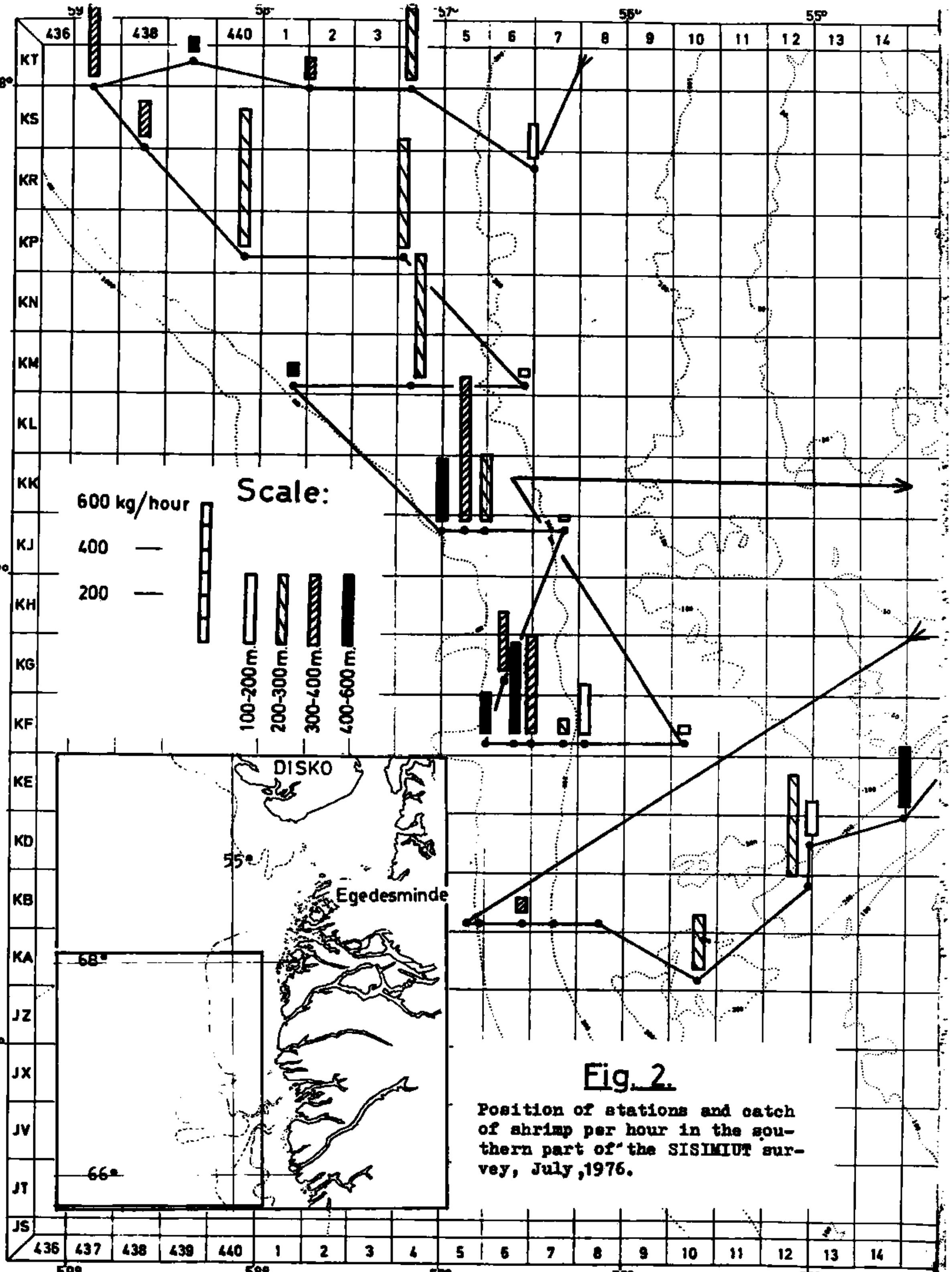

Fig. 2.

Position of stations and catch of shrimp per hour in the southern part of the SISIMIUT survey, July, 1976.

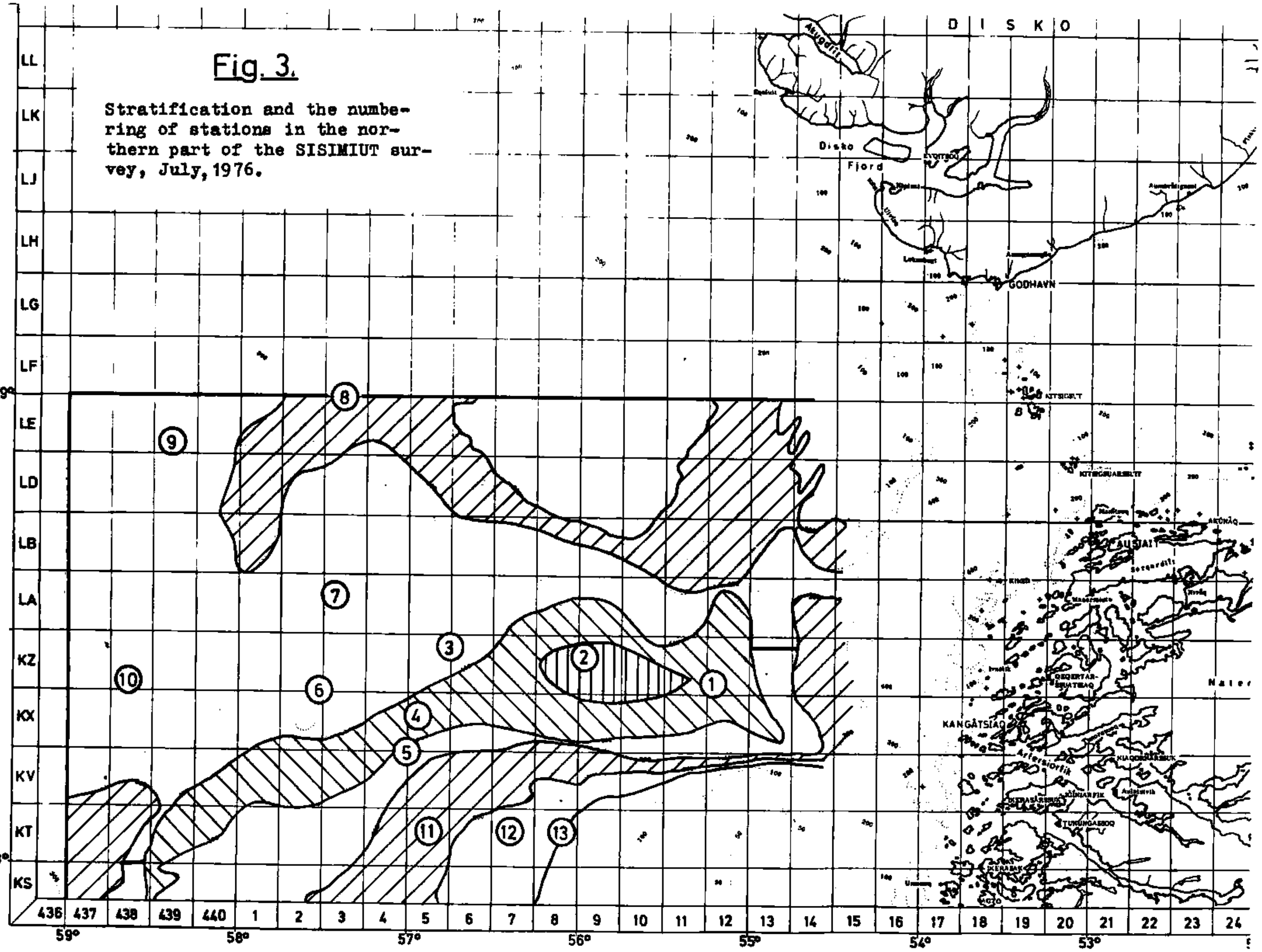

Fig. 3.

Stratification and the numbering of stations in the northern part of the SISIMIUT survey, July, 1976.

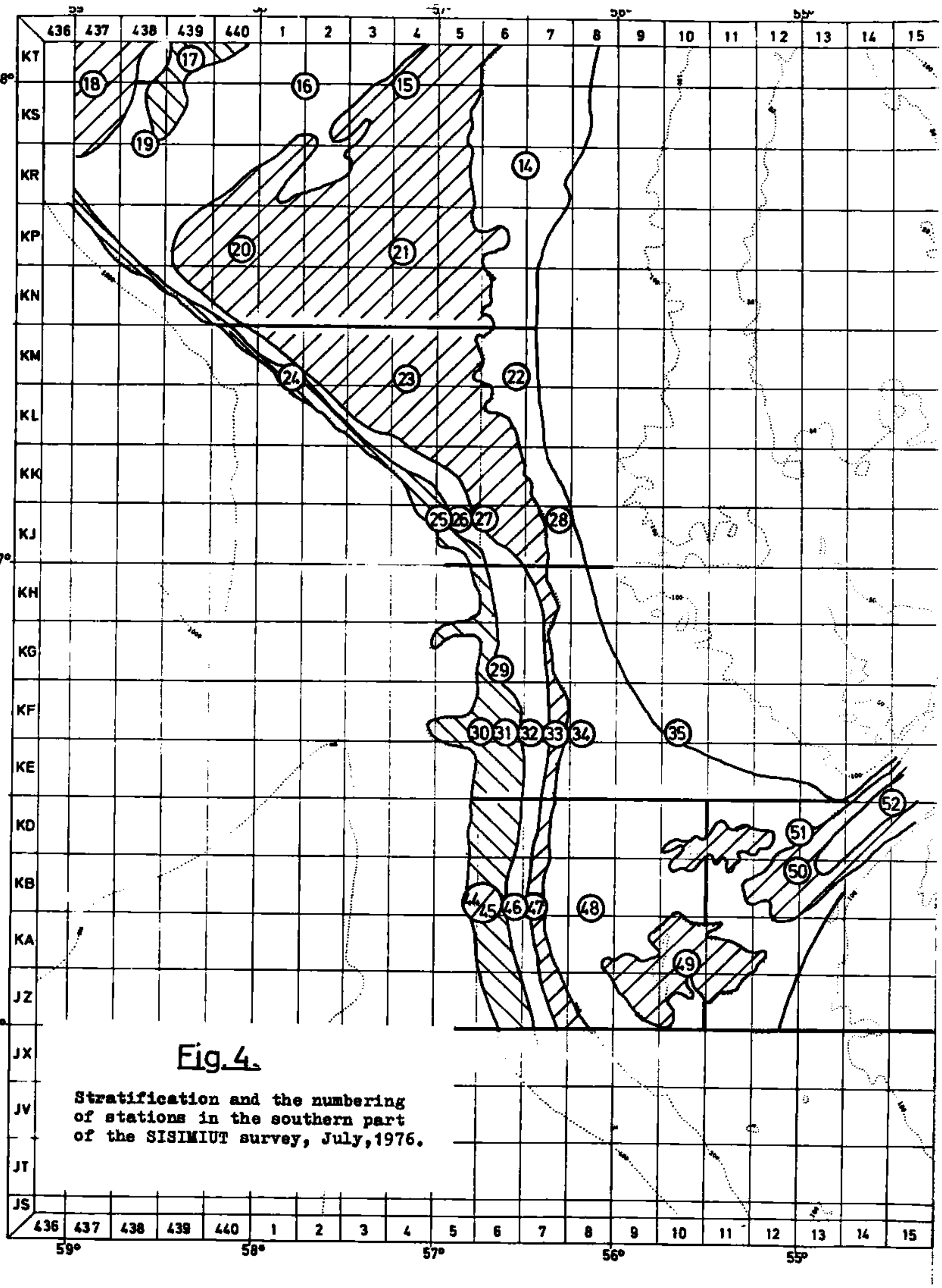

Fig. 4.

Stratification and the numbering of stations in the southern part of the SISIMIUT survey, July, 1976.

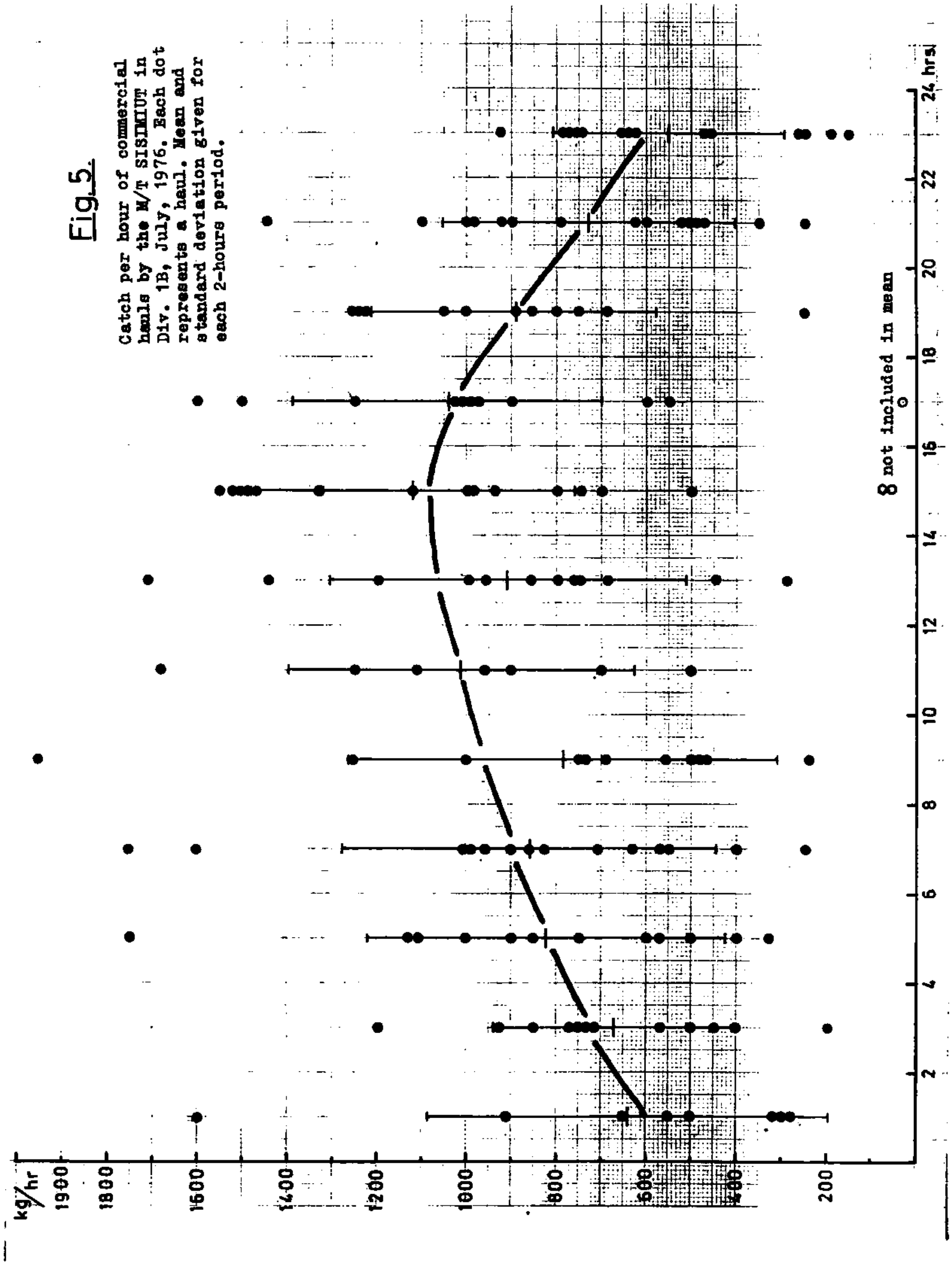

Fig. 5

Catch per hour of commercial hauls by the M/T SISIMIUT in Div. 1B, July, 1976. Each dot represents a haul. Mean and standard deviation given for each 2-hours period.