Northwest Atlantic Fisheries Organization

Serial No. N3030 **NAFO SCR Doc. 98/41**

SCIENTIFIC COUNCIL MEETING - JUNE 1998

An Estimate of By-catch of Fish in the West Greenland Shrimp Fishery Based on Survey Data

by

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Introduction

The catches in the West Greenland shrimp fishery have been rather stable around 40-70.000 tons annually during the latest two decades (Anon. 1997). The amount of by-catch of fish in the shrimp fishery can not be estimated directly because the by-catch figures in the logbooks are considered unreliable. During the past there have been several attempts to estimate the by-catch from survey data and few direct observations from the commercial fishery made by staff from Greenland Institute of Natural Resources (Riget *et al.* 1988, Engelstoft 1996). These investigations indicate that the by catch of small Greenland halibut and small redfish sp. might be considerable. In the present paper the by-catch of a number of fish species in the commercial shrimp fishery in July-August is estimated from a stratified bottom conducted in the same period in NAFO Subarea 1 (Carlsson and Kanneworff 1997ab). Due to an investigation of the variation in the catches of shrimp in the survey, the survey coverage was, in some areas, been better than previous years (Carlsson 1997).

Materials and Methods

The survey was conducted in July-August and covered NAFO Divisions 1A (to 72°N) – 1F between the base line and the 600 m depth contour line, the 200-mile line or the midline to Canada. Further the inshore area Disko Bay was surveyed. The survey area was stratified in NAFO Division. Div. 1B was divided in two strata Div. 1BN and Div. 1BS at 67•N, and Disko Bay was considered as a separate stratum. Towing time was between 30 and 60 min, but all catches were standardised to 60 min. Further information about the survey is given in Carlsson and Kanneworff (1997ab).

The mesh size in the survey trawl was 20-mm, while it is 44-mm in the commercial fishery. Based on comparative trawling with the two mesh sizes in 1993 a conversion factor for the catchability by length was estimated for redfish sp. by Bech (1994):

n(6cm)=N/2.53
n(7cm)=N/7.69
n(8cm)=N/7.38
n(9cm)=N/4.60
n(10cm)=N/2.93

where n = numbers of fish in 44 mm mesh and N = numbers in 20 mm mesh by length group.

The estimate for 6-cm fish was based on very few observations and the factor for 5 and 6-cm fish was set at 7.69 in this investigation. There was no significant difference in the selectivity of Greenland halibut in the two mesh sizes (Bech 1994) and it was assumed that there was no difference in the selectivity of the other fish species dealt with here.

To recalculate the catch weight of redfish sp. (most likely *S. mentella*) in a 44-mm mesh was used a length-weight relationship obtained from West Greenland in 1987:

$$w = 0.009565 * l^{3.112}$$

where w = weight in g and l = length in cm.

Tests on survey samples from 1997 containing fish > 10 cm, only, showed however, that the regression overestimated the catch weight by 5-10 %, but the regression is used because no better is available.

Catches of shrimps had not been adjusted for differences between the two mesh sizes, because the contribution in weight from small shrimps caught in a 20-mm net but not in a 44-mm net, was considered to be negligible (Carlsson *pers. com.*).

The lowest average commercial CPUE (by NAFO Division) in July-August was about 103 kg per hour in Div. 1BN. This figure contains data from a number of small vessels and the CPUE on 43 kg per hour in Disko Bay was based on small vessels only. In order to estimates the by-catch in the commercial fishery, only survey hauls with shrimp catches > 100 kg per hour were used.

In 38 hauls in Div. 1BN only data on shrimp, Greenland halibut and redfish sp. were recorded (Carlsson 1997).

The by-catch was estimated as kg (or number) of fish per kg shrimp by haul, and the mean by-catch per kg shrimp was estimated by NAFO Division. The commercial by-catch (by NAFO Division) was estimated by multiplying the estimated by-catch with the commercial catch of shrimp in July-August. The variance was given as +/- 2*S.E. The estimations were restricted to the survey period because it is known that at least Greenland halibut (Jørgensen 1997) but probably also other fish species undertake seasonal migrations.

Results and Discussion

In total 278 successful hauls were made. The survey catches of shrimp (*Pandalus borealis*) varied between 0 and 5912.5 kg (Fig.1). The estimation of by-catch of Greenland halibut and redfish sp. in the commercial shrimp fishery was based on 107 hauls, while 69 hauls could be used for estimation of by-catch of other fish species. The hauls used in the estimations were very uneven distributed with the majority of the hauls located in Div. 1BN and Disko Bay. There were hence no hauls in Div. 1BS and very few hauls in the other Divisions (Table 1.). This makes the estimation of by-catches in these Divisions extremely uncertain and the results should be interpreted very cautiously.

The shrimp catches in the commercial fishery in July-August varied between 2 tons in Div. 1A (south of 72°N) and 2534 tons in Div. 1D (Table 1). The total offshore shrimp catch was 9150 tons while 1832 tons were caught in the inshore area Disko Bay during the period. It should be kept in mind, that in the three Divisions with shrimp catches of more than 2000 tons, there have been only in total 14 survey hauls useful for estimation of the by-catch in the commercial shrimp fishery.

Redfish

Only few redfish were determined to species. Golden redfish (*S. marinus*) was recorded in very few numbers and was not included in the estimations. Deep-sea redfish (*S. mentella*) was recorded sporadically in Disko Bay and Div. 1E and more frequently in Div. 1F with up to 175 kg and 1907 specimens in one haul. Redfish sp. (probably *S. mentella*) was recorded from all Divisions but with the highest catches in Div. 1BN (to 2781.6 kg and 291559.2 specimens). The distribution of catches of redfish sp. and deep-sea redfish combined in the 20-mm survey trawl is shown by weight and number in Fig. 2 and 3, respectively, and by weight and number recalculated to a 44-mm commercial trawl in Fig. 4 and 5.

The by-catch of redfish sp. converted to a commercial 44-mm trawl varied between 0.287 kg in Div 1BN and 0.007 kg in Disko Bay corresponding to 15.441 and 0.065 specimens per kg shrimp (Table 1). The total by-catch of redfish sp. in the offshore commercial fishery was estimated at 899.6 (83.0 – 1855.2) tons corresponding to $3.0*10^7$ ($7.7*10^6$ – $5.3*10^7$) specimens. The highest by-catch was found in Div. 1BN 392.0 (77.9-706.2) tons, but also in Div. 1C the estimated by-catch of redfish was large (Table 1). As mentioned in "Material and Methods" the by-catch weight is probably overestimated by 5-10 %.

The selectivity in a commercial 44-mm trawl towed for 2-5 hours and hence more or less full is probably low and, further, the survival rate of small redfish that escapes through the trawl is probably reduced. The by-catch figures in the 20-mm survey trawl was estimated at 1089.2 tons and $6.6*10^7$ (Table 2). The difference in by-catches in kg in the two mesh sizes was only about 200 tons, while the by-catch in terms of numbers was reduced from $6.6*10^7$

specimens in the 20-mm mesh to $3.0*10^7$ in the 44-mm trawl. The "true" by-catch figures are probably somewhere between the two estimates.

By-catch of deep-sea redfish was only observed in notable amounts in Div. 1F where the by-catch was estimated to 0.015 kg/0.161 specimen per kg shrimp. The total offshore commercial by-catch was estimated at 31.0 tons (0 – 76.5 tons) and $3.4*10^5$ (0 - $8.6*10^5$) specimens (Table 3). The survey catches have not been converted to commercial catches because almost all the deep-sea redfish were above 10 cm (Fig. 6).

The overall length distribution of redfish sp. ranged from 5 to 45 cm. The length distributions in the 20-mm survey trawl were dominated by fish smaller than 10 cm in all Divisions except Div. 1A where there were few observations and in Div. 1F. In Div. 1F the length distribution was dominated by two modes at 13 and 16 cm (Fig. 6). The length distributions converted to 44-mm trawl were still dominated by fish smaller than 10 cm, but to a much lesser degree than in the 20-mm trawl (Fig. 6).

The length distribution of deep-sea redfish in Div. 1F ranged from 5 to 32 cm but was dominated by a single mode between 15 and 20 cm. There was only a minor difference in the distribution in the two mesh sizes (Fig. 6).

Compared to the present investigations Riget *et al.* (1988) and Engelstoft (1996) stratified the survey area somewhat different, they selected relevant survey hauls for by-catch estimations in a different way and they estimated by-catch as total catch of fish (kg or number)/total catch of shrimp (kg) by stratum. However, in both papers the largest by-catches of redfish sp. were found in Div. 1B while the by-catches were somewhat lower in the more southern Divisions as seen in these investigations. Riget *et al.* (1988) observed by-catches in the range 1.8-13.5 redfish per kg shrimp in a stratum almost identical to Div. 1BN for the period 1968-1987. Engelstoft (1996) found an average of 6.7 redfish per kg shrimp in Div. 1B for the period 1989-1995 (44-mm mesh) compared to 15.4 specimens in these investigations. The high estimate in 1997 is probably bescuse the abundance and biomass of redfish sp. is the highest observed in the period 1988-1997 (Engelstoft and Jørgensen 1998). Engelstoft's (1996) figures from Div.1C - 1F are slightly higher than estimated here. Riget *et al.* (1988) also found relatively high by-catches in Disko Bay (3.36 specimens per kg shrimp) in contradiction to these investigations and Engelstoft (1996).

The average length distributions in 1968-87 was generally dominated by fish between 10 and 20 cm in the northern Divisions, while there were more large fish (30-40 cm) in the southern Divisions (Riget *et al.* 1988). In these investigations were most fish in the northern Divisions below 10 cm and there were almost no large (30-40 cm) fish in the southern Divisions. The length distributions given by Engelstoft (1996) were rather similar to those given here (fig. 6).

The size of the redfish sp. catches were not correlated with the size of the shrimp catches neither in terms weight ($p=0.329$, $r=0.095$) nor in terms of number ($p=0.234$, $r=0.116$).

Greenland halibut

Greenland halibut was caught in all Divisions but with the highest catches in Disko Bay (to 205.4 kg/4605 specimen). The distribution of catches of Greenland halibut (all survey hauls) is shown by weight and number in Fig. 7 and 8.

The by-catch of Greenland halibut varied between 0.166 kg in Disko Bay and 0.000 kg in Div. 1E corresponding to 2.449 and 0.001 specimens per kg shrimp, respectively (Table 4). The total by-catch of Greenland halibut in the offshore commercial fishery was estimated at 287.8 (40.3 - 625.8) tons and $3.3*10^6$ ($8.4*10^5$ – $6.6*10^6$) specimens. The highest by-catch was observed in Div. 1C in terms of weight, but the by-catch was at the same level in terms of number in Div. 1BN. It is however noteworthy that the estimated by-catch in the Disko bay seems to be larger than the estimated by-catch in the offshore area *i.e.* 304.1 (201.5-406.7) tons and $4.5*10^6$ ($3.1*10^6$-$5.9*10^6$) specimens.

The overall length distribution ranged from 6 to 75 cm, but with very few fish above 50 cm. The length distribution Div. 1BN was dominated by a clear mode around 13 cm and a minor mode around 19 cm. A mode around 17 cm was seen in Div. 1C, but the length distribution was dominated by fish larger than 20 cm, which was also seen in Div. 1F. There were to few observations in the other offshore Divisions to make any firm conclusions about the length distributions. The length distribution in Disko Bay was dominated by a clear mode around 19 cm and a smaller one around 13 cm (Fig. 9).

Riget *et al.* (1988) calculated the average by-catch at the northern slope of Store Hellefiske Banke (almost equal to Div. 1BN) to be between 1.07 and 2.98 Greenland halibut per kg shrimp for the period 1968-1987, compared to 1.1 in Div. 1BN in these investigations and 0.76 as an average for the period 1989-1995 in Div. 1B (Engelstoft 1996). In

all three investigations the by-catch of Greenland halibut was considerable lower in all other Divisions. The only exception was in Div. 1C where it was 0.74 in these investigations compared to 0.12 and 0.18 in Riget *et al.* (1988) and Engelstoft (1996), respectively. Riget *et al.* (1988) found the largest by-catch of Greenland halibut in Disko Bay (4.25), as also observed in these investigations, while Engelstoft (1996) only estimated the by-catch to 0.73 specimens per kg shrimp.

In all three investigations the length distributions in Div. 1B and Disko Bay were dominated by two modes at about 13 cm and 18 cm. In 1968-1987 fish smaller than 20 cm were also dominating in the more southern Divisions (Riget *et al.* 1988). The length distributions given by Engelstoft (1996) are close to what is shown here (Fig. 9), although the relative size of the modes differs somewhat.

The size of the catches of Greenland halibut was correlated with the size of the shrimp catch both in terms of weight ($p=0.01$) and number ($p=0.02$) but the correlation coefficients were low, $r=0.248$ and $r=0.233$, respectively.

American plaice

American plaice was observed in all Divisions with the highest catches in terms of weight in Disko Bay (10.2 kg) and in Div. 1C in terms of numbers (184 specimens).

The by-catch of American plaice varied between 0.010 kg in Div. 1C and 0.000 kg in Div. 1E corresponding to 0.280 and 0.003 specimens per kg shrimp (Table 5). The total offshore by-catch of American plaice in the commercial fishery was estimated at 46.0 (4.8 – 108.2) tons and $8.5*10^5$ ($1.9*10^4 - 2.2*10^6$) specimens with the highest by-catch in Div. 1C (Table 5).

Overall the length ranged between 7 and 43 cm. The length distribution in Div. 1C was dominated by a mode at 14 cm. American plaice in the other Divisions were generally larger and several minor modes were seen (Fig. 10).

Skate (Raja radiata)

Skate was caught in all Divisions with the highest catches in terms of weight in Disko Bay (18.2 kg) and in Div. 1BN in terms of numbers (58 specimens).

The by-catch of skate varied between 0.021 kg in Div. 1A and 0.000 kg in Div. 1E corresponding to 0.031 and 0.000 specimens per kg shrimp (Table 6). (Only a single specimen was caught in Div. 1E). The total by-catch of skate in the offshore commercial fishery was estimated at 27.3 (2.1 – 52.5) tons and $1.5*10^5$ ($4.2*10^4 - 2.8*10^5$) specimens with the highest estimate from Div. 1BN. The estimated by-catch was also relatively high in Disko Bay 16.5 (9.2 – 23.8) tons (Table 6).

Overall the length ranged between 9 and 54 cm. The length distributions in both Div. 1BN and Disko Bay showed a number of modes (Fig. 11). (There were to few observations in the other divisions to make meaningful length distributions).

Atlantic wolffish (Anarhichas lupus)

Atlantic wolffish was only recorded sporadically with the highest catches in terms of weight in Div. 1BN (4.0 kg, 1 specimen) and in Disko Bay in terms of numbers (4 specimens). In total 15 specimens in the range 21 – 70 cm were caught

The by-catch of Atlantic wolffish varied between 0.003 kg in Div. 1D and 0.000 kg in all other Divisions except Div. 1BN corresponding to 0.001 and 0.000 specimens per kg shrimp (Table 7). The total by-catch of skate in the offshore commercial fishery was estimated at 10.3 (0 – 28.3) tons and $7.3*10^3$ ($2.1*10^3 - 1.9*10^4$) specimens with the highest by-catch in Div. 1D (Table 7).

Spotted wolffish (Anarhichas minor)

Spotted wolffish was only recorded sporadically with the highest catches in Div. 1C (1.4 kg/11 specimens). In total 28 specimens in the range 11-50 cm were caught.

The by-catch of spotted wolffish varied between 0.001 kg in Div. 1C and 0.000 kg in all other Divisions to 0.003 and 0.000 specimens per kg shrimp (Table 8). The total by-catch of skate in the offshore commercial fishery was

estimated at 2.1 (0 – 6.2) tons and $1.3*10^4$ ($8.7*10^3$ – $2.2*10^4$) specimens, which was mainly taken in Div. 1C (Table 8).

Cod

Only two cod were caught in Div. 1C.

General Discussion

Engelstoft (1996) estimated very low by-catches (< 0.0 specimens per kg shrimp) of American plaice, cod and spotted - and Atlantic wolffish during the period 1989-1995. The very small by-catches of these species also observed in these investigations must be due to the depleted status of the stocks (Anon. 1997).

The overlap between the distribution of the shrimp stock and Greenland halibut and redfish stocks implies that the problem with by-catches in the shrimp fishery can not be solved by closing certain areas. The only way to solve the problem is by technical solutions as separator grids. In the near future separator grids (barwith 22 mm) will be mandatory on all larger offshore shrimp trawlers.

Greenland has recently introduced an observer program with full coverage of all offshore trawlers. It is expected that this will improve the information about the by-catches in the shrimp fishery and hence give a much better estimate of the extend of the by-catch in the shrimp fishery than presented here.

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Table 1. Redfish sp. 44-mm commercial trawl. By-catches in kg and number (no.) with S.E. and min and max observation. n=number of hauls. Total shrimp catch (Catch) in July-August, total estimated by-catch in tons (Byc.t.) and numbers (Byc. no.) and +/- 2*S.E. (max min). The shrimp catch in 1BS was 342 tons.

	n	kg	S.E	min	max	no.	S.E	Min	max
Disko Bay	33	0.007	0.003	0.000	0.100	0.065	0.025	0.000	0.676
1A	1	0.008		0.008	0.008	0.350		0.350	0.676
1BN	57	0.287	0.115	0.000	5.961	15.411	5.502	0.000	285.257
1C	7	0.168	0.097	0.000	0.646	2.147	0.908	0.125	5.549
1D	2	0.032	0.023	0.008	0.055	1.182	0.418	0.763	1.600
1E	2	0.003	0.000	0.003	0.003	0.154	0.043	0.111	0.196
1F	5	0.030	0.027	0.000	0.138	0.644	0.517	0.000	2.679

	Catch	Byc. t.	min	max	Byc. no.	min	max
Disko Bay	1832	12.8	1.8	23.8	1.2E+05	2.7E+04	2.1E+05
1A	2	0.0	0.0	0.0	7.0E+02	7.0E+02	7.0E+02
1BN	1366	392.0	77.9	706.2	2.1E+07	6.0E+06	3.6E+07
1C	2073	348.3	0.0	750.4	4.5E+06	6.9E+05	8.2E+06
1D	2534	81.1	0.0	197.7	3.0E+06	8.8E+05	5.1E+06
1E	1107	3.3	3.3	3.3	1.7E+05	7.5E+04	2.7E+05
1F	2068	62.0	0.0	173.7	1.3E+06	0.0E+00	3.5E+06
Total offsh	9150	886.8	81.2	1831.3	3.0E+07	7.7E+06	5.3E+07

Table 2. Redfish sp. 20-mm survey trawl. By-catches in kg and number (no.) with S.E. and min and max observation. n=number of hauls. Total shrimp catch (Catch) in July-August, total estimated by-catch in tons (Byc.t.) and numbers (Byc. no.) and +/- 2*S.E. (max min). The shrimp catch in 1BS was 342 tons.

	n	kg	S.E	Min	max	no.	S.E	min	max
Disko Bay	33	0.007	0.003	0.000	0.094	0.084	0.028	0.000	0.721
1A	1	0.008		0.008	0.008	0.361		0.361	0.361
1BN	57	0.429	0.127	0.000	6.312	37.854	9.059	0.000	389.891
1C	7	0.162	0.082	0.001	0.567	2.352	0.926	0.048	5.789
1D	2	0.041	0.011	0.029	0.052	3.064	0.966	2.098	4.031
1E	2	0.005	0.002	0.003	0.007	0.454	0.260	0.193	0.714
1F	5	0.028	0.023	0.000	0.122	0.691	0.545	0.001	2.852

	Catch	Byc. t.	min	max	Byc. no.	min	max
Disko Bay	1832	12.8	1.8	23.8	1.5E+05	5.1E+04	2.6E+05
1A	2	0.0	0.0	0.0	7.2E+02	7.2E+02	7.2E+02
1BN	1366	586.0	239.1	933.0	5.2E+07	2.7E+07	7.6E+07
1C	2073	335.8	0.0	675.8	4.9E+06	1.0E+06	8.7E+06
1D	2534	103.9	48.1	159.6	7.8E+06	2.9E+06	1.3E+07
1E	1107	5.5	1.1	10.0	5.0E+05	0.0E+00	1.1E+06
1F	2068	57.9	0.0	153.0	1.4E+06	0.0E+00	3.7E+06
Total offsh	9150	1089.2	288.3	1931.4	6.6E+07	3.1E+07	1.0E+08

Table 3. Deep-sea redfish. 20 mm survey trawl. By-catches in kg and number (no.) with S.E. and min and max observation. n=number of hauls. Total shrimp catch (Catch) in July-August, total estimated by-catch in tons (Byc.t.) and numbers (Byc. no.) and +/- 2*S.E. (max min). The shrimp catch in 1BS was 342 tons.

	n	Kg	S.E	min	max	no.	S.E	min	max
Disko Bay	33	0.000	0.000	0.000	0.002	0.001	0.001	0.000	0.023
1A	1	0.000		0.000	0.000	0.000		0.000	0.000
1BN	19	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1C	7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1D	2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1E	2	0.000	0.000	0.000	0.001	0.004	0.004	0.000	0.009
1F	5	0.015	0.011	0.000	0.059	0.161	0.125	0.000	0.645

	Catch	Byc. t.	min	max	Byc. no.	min	max
Disko Bay	1832	0.0	0.0	0.0	1.8E+03	0.0E+00	5.5E+03
1A	2	0.0	0.0	0.0	0.0E+00	0.0E+00	0.0E+00
1BN	1366	0.0	0.0	0.0	0.0E+00	0.0E+00	0.0E+00
1C	2073	0.0	0.0	0.0	0.0E+00	0.0E+00	0.0E+00
1D	2534	0.0	0.0	0.0	0.0E+00	0.0E+00	0.0E+00
1E	1107	0.0	0.0	0.0	4.4E+03	0.0E+00	1.3E+04
1F	2068	31.0	0.0	76.5	3.3E+05	0.0E+00	8.5E+05
total offsh	9150	31.0	0.0	76.5	3.4E+05	0.0E+00	8.6E+05

Table 4. Greenland halibut. By-catches in kg and number (no.) with S.E. and min and max observation. n=number of hauls. Total shrimp catch (Catch) in July-August, total estimated by-catch in tons (Byc.t.) and numbers (Byc. no.) and +/- 2*S.E. (max min). The shrimp catch in 1BS was 342 tons.

	n	Kg	S.E	Min	max	no.	S.E	min	max
Disko Bay	33	0.166	0.028	0.000	0.562	2.449	0.382	0.000	9.383
1A	1	0.009		0.009	0.009	0.084		0.084	0.084
1BN	57	0.064	0.018	0.000	0.752	1.113	0.252	0.000	9.913
1C	7	0.090	0.065	0.000	0.458	0.737	0.533	0.000	3.773
1D	2	0.003	0.003	0.000	0.006	0.081	0.081	0.000	0.161
1E	2	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.001
1F	5	0.003	0.001	0.000	0.006	0.010	0.003	0.001	0.019

	Catch	Byc. t.	min	Max	Byc. no.	min	max
Disko Bay	1832	304.1	201.5	406.7	4.5E+06	3.1E+06	5.9E+06
1A	2	0.0	0.0	0.0	1.7E+02	1.7E+02	1.7E+02
1BN	1366	87.4	38.2	136.6	1.5E+06	8.3E+05	2.2E+06
1C	2073	186.6	0.0	456.1	1.5E+06	0.0E+00	3.7E+06
	2534	7.6	0.0	22.8	2.1E+05	0.0E+00	6.2E+05
1E	1107	0.0	0.0	0.0	1.1E+03	0.0E+00	3.3E+03
1F	2068	6.2	2.1	10.3	2.1E+04	8.3E+03	3.3E+04
total offsh	9150	287.8	40.3	625.8	3.3E+06	8.4E+05	6.6E+06

Table 5. American plaice. By-catches in kg and number (no.) with S.E. and min and max observation. n=number of hauls. Total shrimp catch (Catch) in July-August, total estimated by-catch in tons (Byc.t.) and numbers (Byc. no.) and +/- 2*S.E. (max min). The shrimp catch in 1BS was 342 tons.

	n	Kg	S.E	min	max	no.	S.E	min	max
Disko Bay	33	0.009	0.002	0.000	0.062	0.071	0.022	0.000	0.721
1A	1	0.005		0.005	0.005	0.031		0.031	0.031
1BN	19	0.004	0.001	0.000	0.016	0.024	0.005	0.000	0.085
1C	7	0.010	0.007	0.000	0.052	0.280	0.225	0.000	1.621
1D	2	0.007	0.006	0.001	0.013	0.081	0.074	0.007	0.155
1E	2	0.000	0.000	0.000	0.000	0.003	0.002	0.001	0.004
1F	5	0.001	0.000	0.000	0.001	0.012	0.008	0.000	0.042

	Catch	Byc. t.	min	max	Byc. no.	min	max
Disko Bay	1832	16.5	9.2	23.8	1.3E+05	4.9E+04	2.1E+05
1A	2	0.0	0.0	0.0	6.2E+01	6.2E+01	6.2E+01
1BN	1366	5.5	2.7	8.2	3.3E+04	1.9E+04	4.6E+04
1C	2073	20.7	0.0	49.8	5.8E+05	0.0E+00	1.5E+06
1D	2534	17.7	0.0	48.1	2.1E+05	0.0E+00	5.8E+05
1E	1107	0.0	0.0	0.0	3.3E+03	0.0E+00	7.7E+03
1F	2068	2.1	2.1	2.1	2.5E+04	0.0E+00	5.8E+04
total offsh	9150	46.0	4.8	108.2	8.5E+05	1.9E+04	2.2E+06

Table 6. Skate. By-catches in kg and number (no.) with S.E. and min and max observation. n=number of hauls. Total shrimp catch (Catch) in July-August, total estimated by-catch in tons (Byc.t.) and numbers (Byc. no.) and +/- 2*S.E. (max min). The shrimp catch in 1BS was 342 tons.

	n	Kg	S.E	min	max	no.	S.E	min	max
Disko Bay	33	0.009	0.002	0.000	0.047	0.020	0.006	0.000	0.201
1A	1	0.021		0.021	0.021	0.031		0.031	0.031
1BN	19	0.008	0.004	0.000	0.067	0.044	0.016	0.005	0.258
1C	7	0.003	0.001	0.000	0.010	0.027	0.020	0.000	0.150
1D	2	0.004	0.002	0.001	0.006	0.012	0.001	0.011	0.013
1E	2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
1F	5	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.004

	Catch	Byc. t.	min	max	Byc. no.	min	max
Disko Bay	1832	16.5	9.2	23.8	3.7E+04	1.5E+04	5.9E+04
1A	2	0.0	0.0	0.0	6.2E+01	6.2E+01	6.2E+01
1BN	1366	10.9	0.0	21.9	6.0E+04	1.6E+04	1.0E+05
1C	2073	6.2	2.1	10.4	5.6E+04	0.0E+00	1.4E+05
1D	2534	10.1	0.0	20.3	3.0E+04	2.5E+04	3.5E+04
1E	1107	0.0	0.0	0.0	0.0E+00	0.0E+00	0.0E+00
1F	2068	0.0	0.0	0.0	2.1E+03	0.0E+00	6.2E+03
total offsh	9150	27.3	2.1	52.5	1.5E+05	4.2E+04	2.8E+05

Table 7. Atlantic wolffish. By-catches in kg and number (no.) with S.E. and min and max observation. n=number of hauls. Total shrimp catch (Catch) in July-August, total estimated by-catch in tons (Byc.t.) and numbers (Byc. no.) and +/- 2*S.E. (max min). The shrimp catch in 1BS was 342 tons.

	n	Kg	S.E	min	max	no.	S.E	min	max
Disko Bay	33	0.000	0.000	0.000	0.009	0.000	0.000	0.000	0.003
1A	1	0.000		0.000	0.000	0.000		0.000	0.000
1BN	19	0.002	0.001	0.000	0.022	0.002	0.001	0.000	0.021
1C	7	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.002
1D	2	0.003	0.003	0.000	0.007	0.001	0.001	0.000	0.002
1E	2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1F	5	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000

	Catch	Byc. t.	min	max	Byc. no.	min	max
Disko Bay	1832	0.0	0.0	0.0	0.0E+00	0.0E+00	0.0E+00
1A	2	0.0	0.0	0.0	0.0E+00	0.0E+00	0.0E+00
1BN	1366	2.7	0.0	5.5	2.7E+03	0.0E+00	5.5E+03
1C	2073	0.0	0.0	0.0	2.1E+03	2.1E+03	2.1E+03
1D	2534	7.6	0.0	22.8	2.5E+03	0.0E+00	7.6E+03
1E	1107	0.0	0.0	0.0	0.0E+00	0.0E+00	0.0E+00
1F	2068	0.0	0.0	0.0	0.0E+00	0.0E+00	4.1E+03
total offsh	9150	10.3	0.0	28.3	7.3E+03	2.1E+03	1.9E+04

Table 8. Spotted wolffish. By-catches in kg and number (no.) with S.E. and min and max observation. n=number of hauls. Total shrimp catch (Catch) in July-August, total estimated by-catch in tons (Byc.t.) and numbers (Byc. no.) and +/- 2*S.E. (max min). The shrimp catch in 1BS was 342 tons.

	n	Kg	S.E	min	max	no.	S.E	min	max
Disko Bay	33	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1A	1	0.000		0.000	0.000	0.000		0.000	0.000
1BN	19	0.000	0.000	0.000	0.003	0.001	0.000	0.000	0.007
1C	7	0.001	0.001	0.000	0.004	0.003	0.000	0.000	0.006
1D	2	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.002
1E	2	0.000	0.000	0.000	0.000	0.001	0.000	0.001	0.001
1F	5	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.003

	Catch	Byc. t.	min	max	Byc. no.	min	max
Disko Bay	1832	0.0	0.0	0.0	0.0E+00	0.0E+00	0.0E+00
1A	2	0.0	0.0	0.0	0.0E+00	0.0E+00	0.0E+00
1BN	1366	0.0	0.0	0.0	1.4E+03	1.4E+03	1.4E+03
1C	2073	2.1	0.0	6.2	6.2E+03	6.2E+03	6.2E+03
1D	2534	0.0	0.0	0.0	2.5E+03	0.0E+00	7.6E+03
1E	1107	0.0	0.0	0.0	1.1E+03	1.1E+03	1.1E+03
1F	2068	0.0	0.0	0.0	2.1E+03	0.0E+00	6.2E+03
total offsh	9150	2.1	0.0	6.2	1.3E+04	8.7E+03	2.2E+04

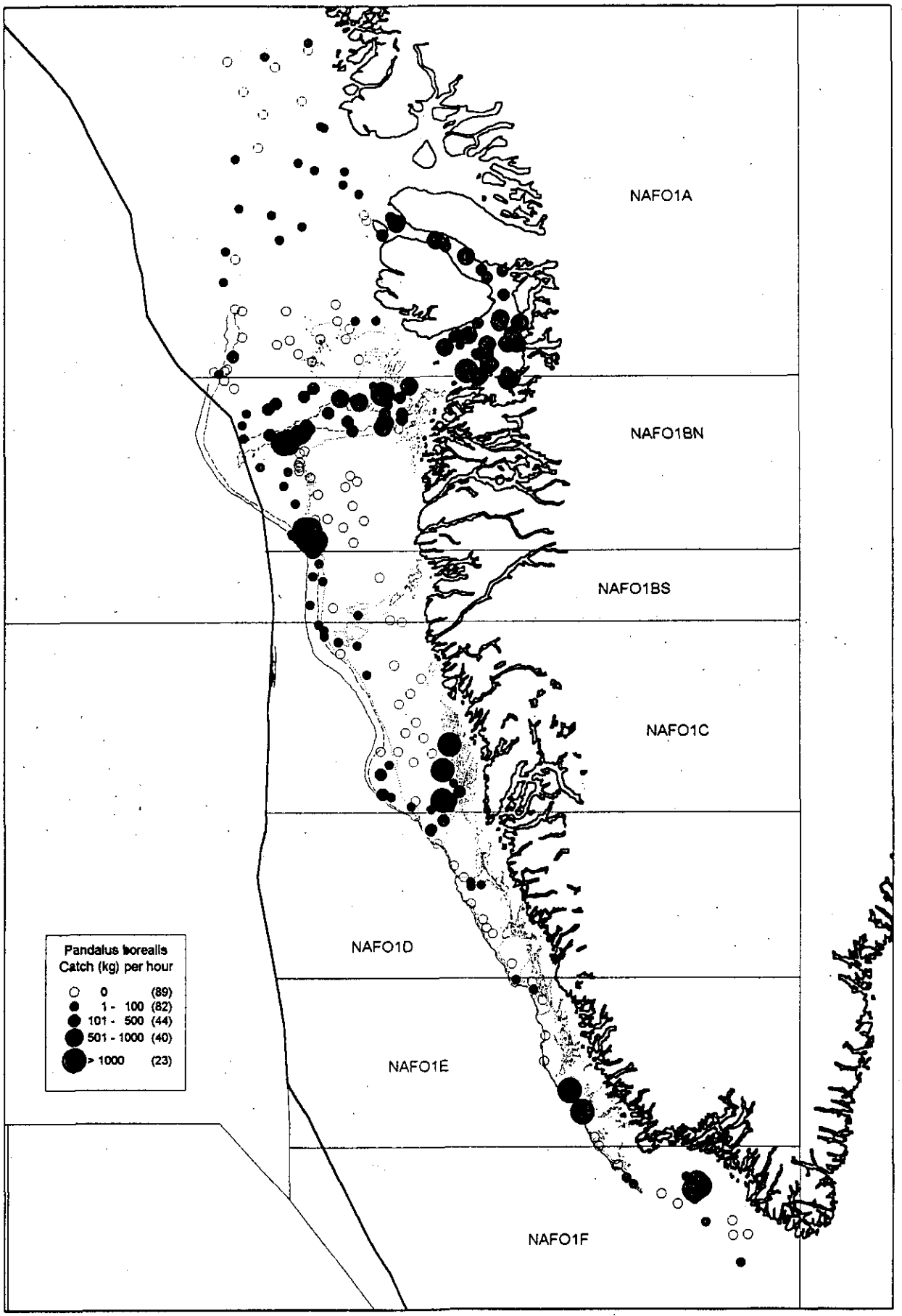


Fig. 1. Distribution of survey catches (kg/hour) of shrimp (*Pandalus borealis*) (all hauls). The midline against Canada and the 200, 400, 600 m depth contour lines are shown.

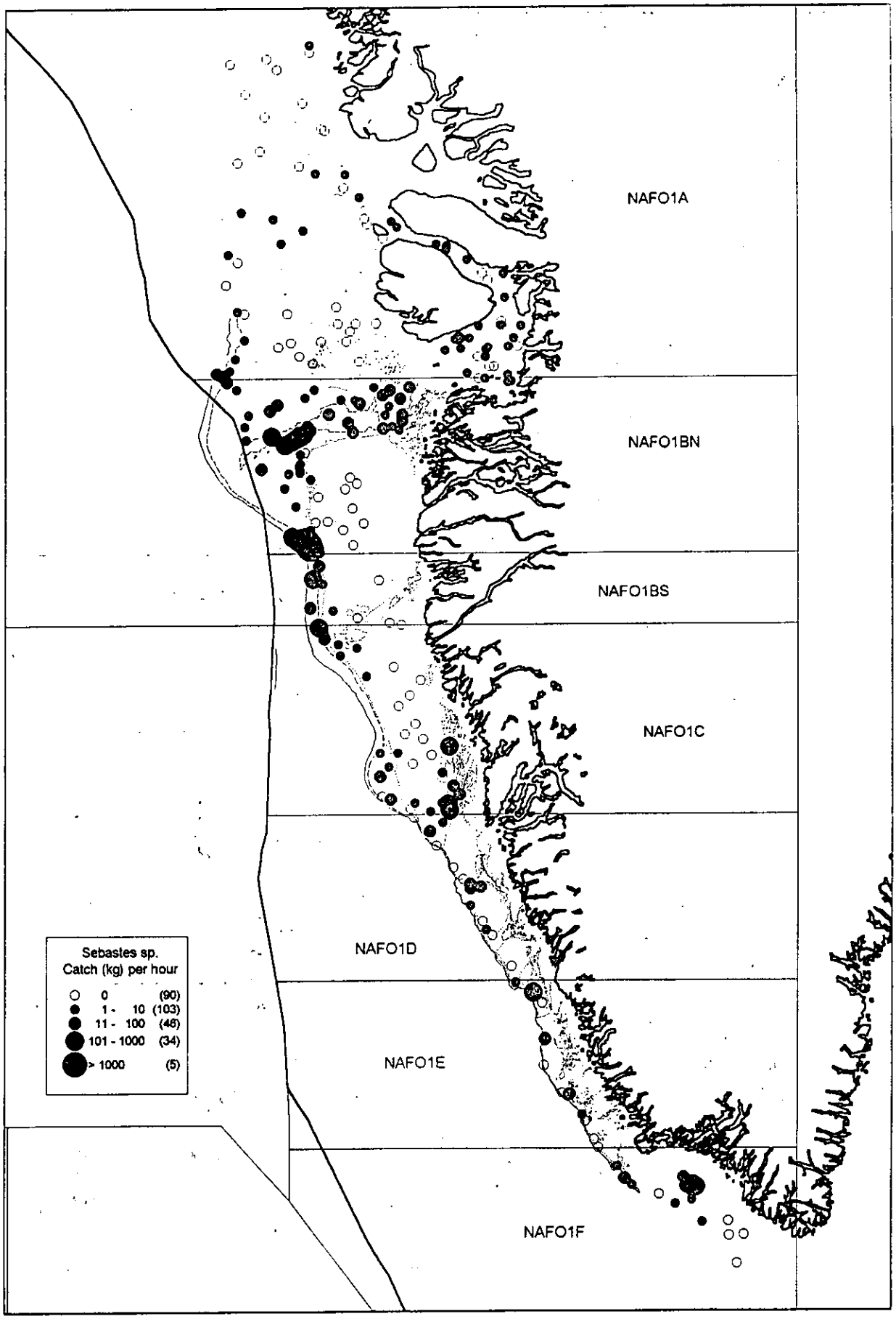


Fig. 2. Distribution of survey catches (kg/hour) of redfish sp. (all hauls). The midline against Canada and the 200, 400, 600 m depth contour lines are shown.

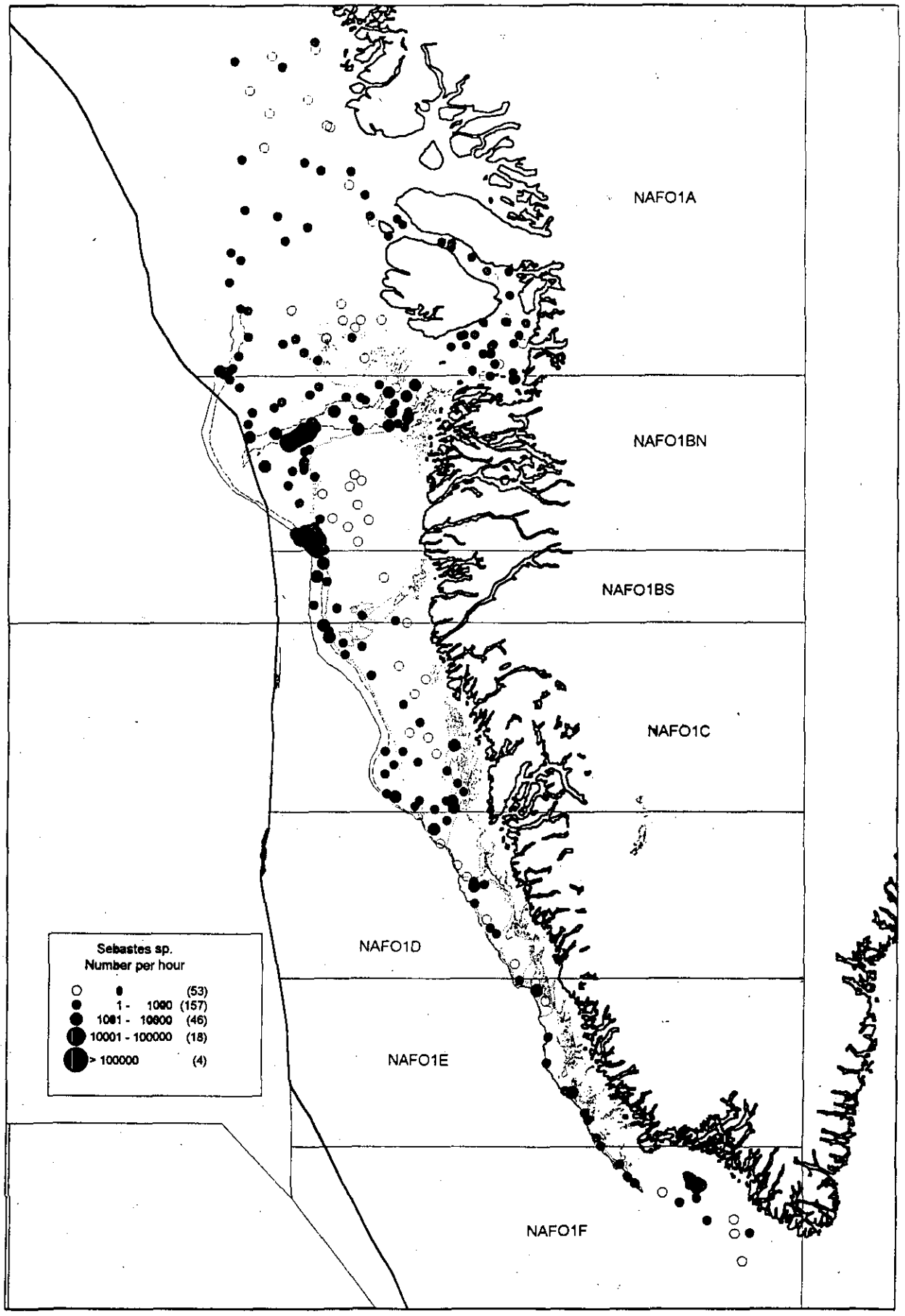


Fig. 3. Distribution of survey catches (number/hour) of redfish sp. (all hauls). The midline against Canada and the 200, 400, 600 m depth counter lines are shown.

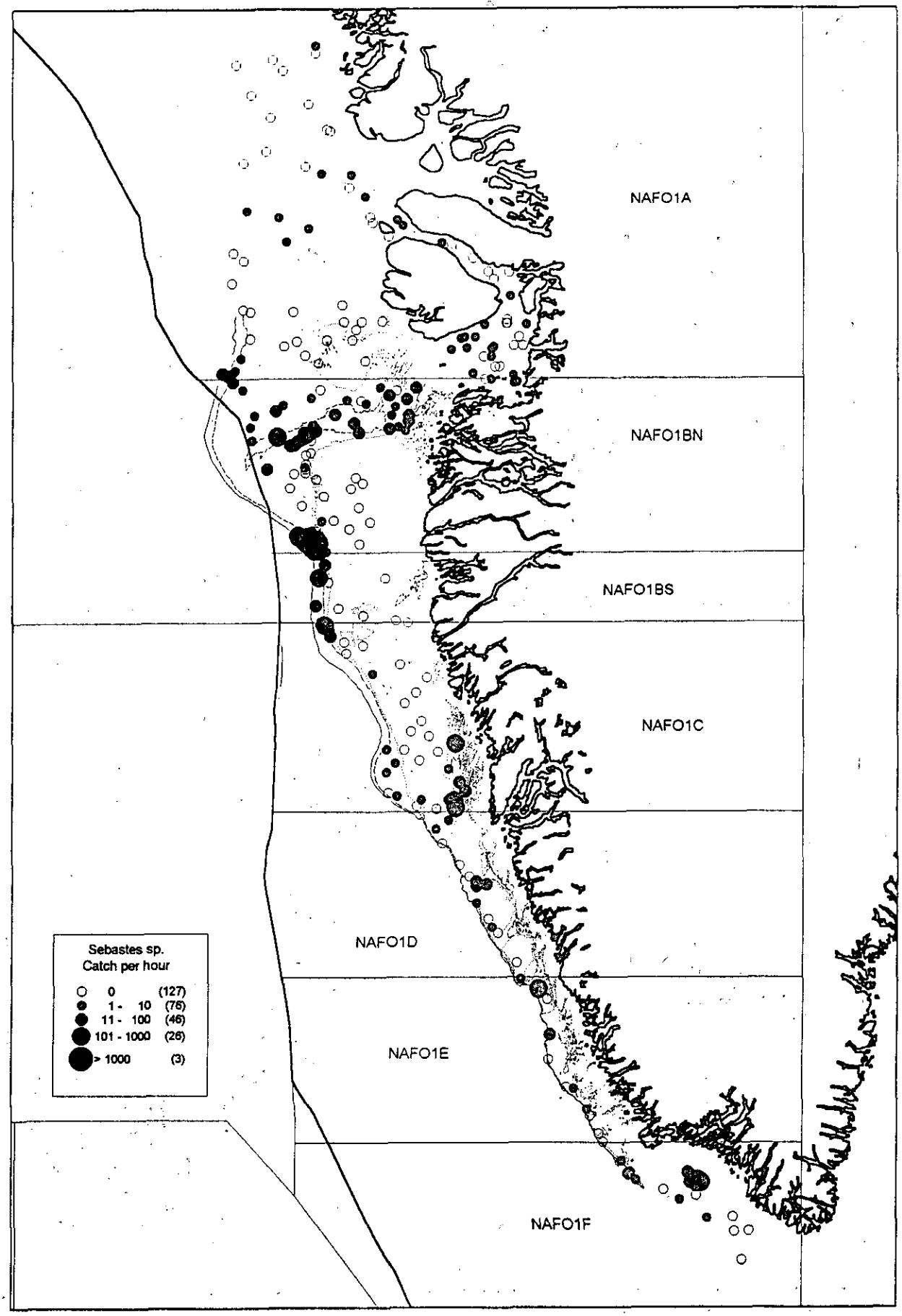


Fig. 4. Distribution of survey catches (kg/hour) of redfish sp. (all hauls). Catches are converted to 44-mm commercial trawl. The midline against Canada and the 200, 400, 600 m depth contour lines are shown.

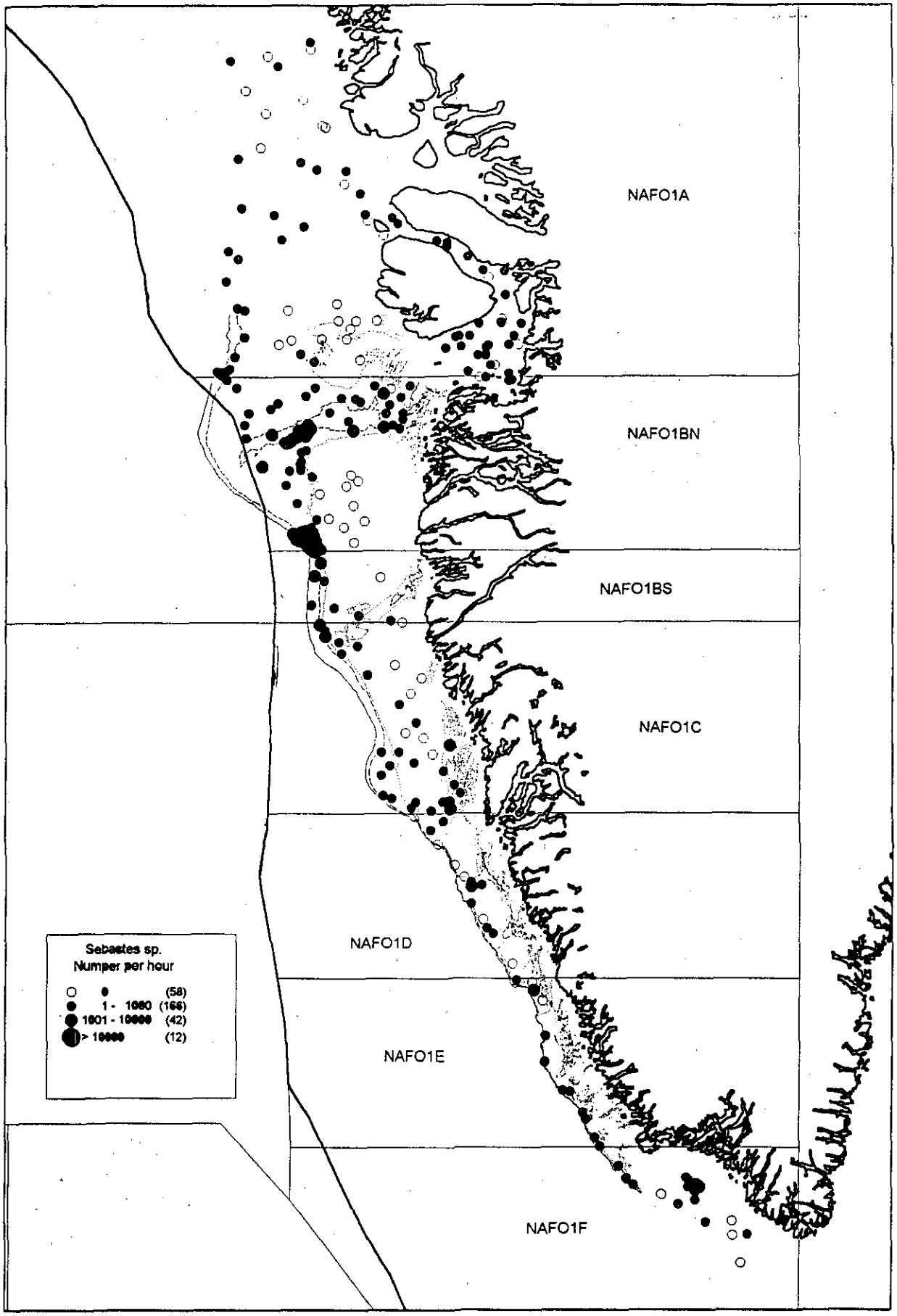


Fig. 5. Distribution of survey catches (number/hour) of redfish sp. (all hauls). Catches are converted to-44 mm commercial trawl. The midline against Canada and the 200, 400, 600 m depth contour lines are shown.

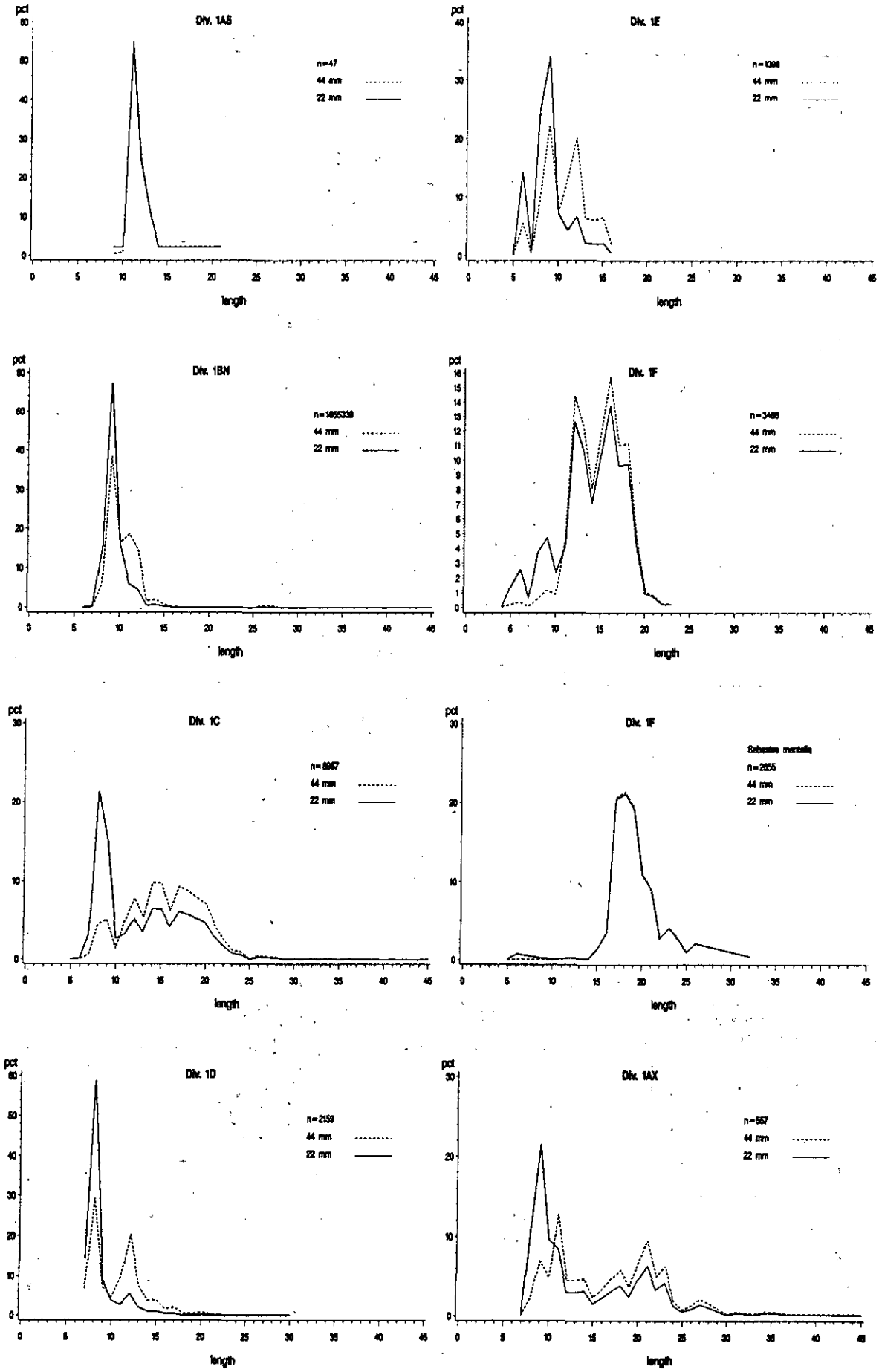


Fig. 6. Length distributions of redfish sp. by NAFO Div. from 20 mm survey trawl and converted to-44 mm commercial trawl. Div. 1AX is Disko Bay. Length distribution of deep-sea redfish in Div. 1F is shown in third panel in second column.

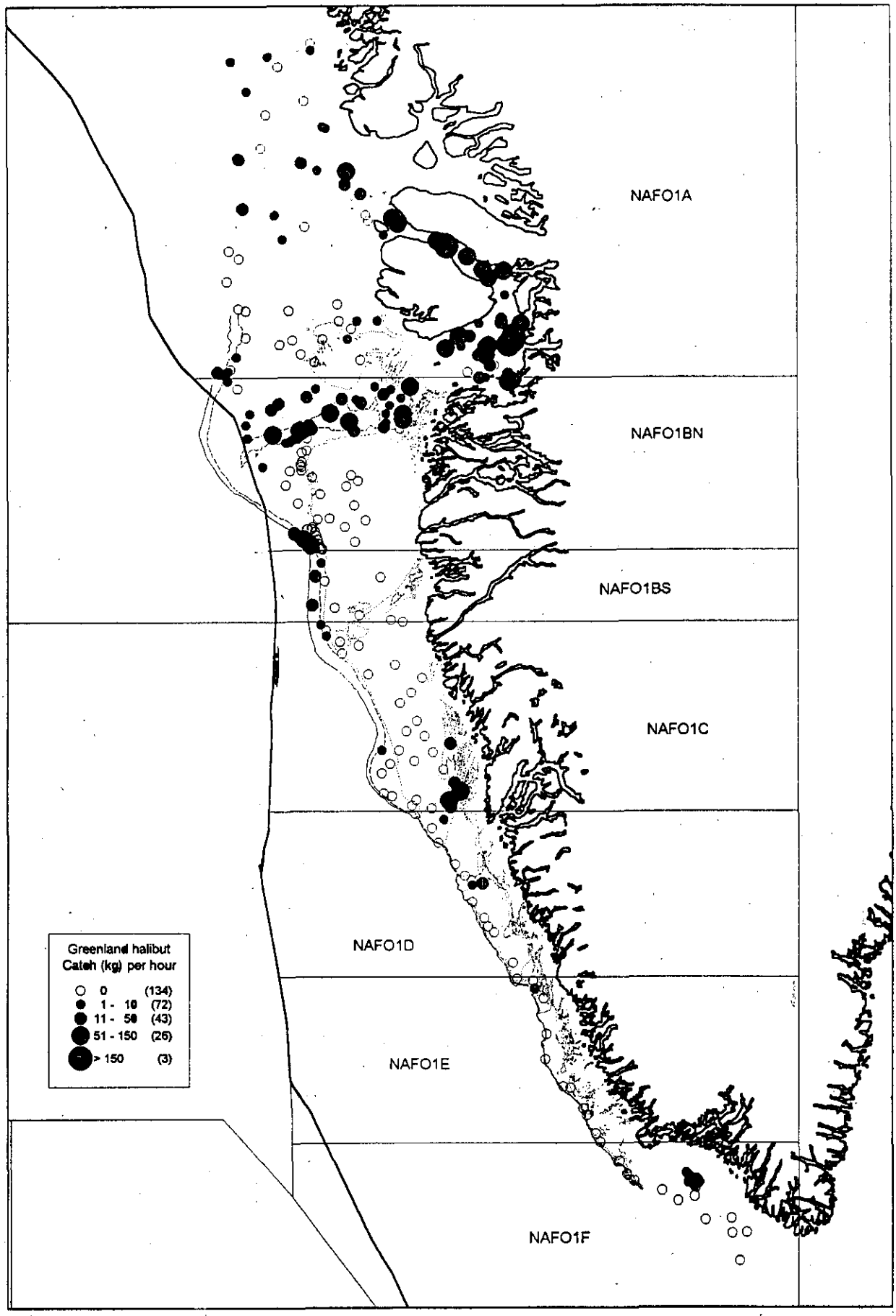


Fig. 7. Distribution of survey catches (kg/hour) of Greenland halibut (all hauls). The midline against Canada and the 200, 400, 600 m depth contour lines are shown.

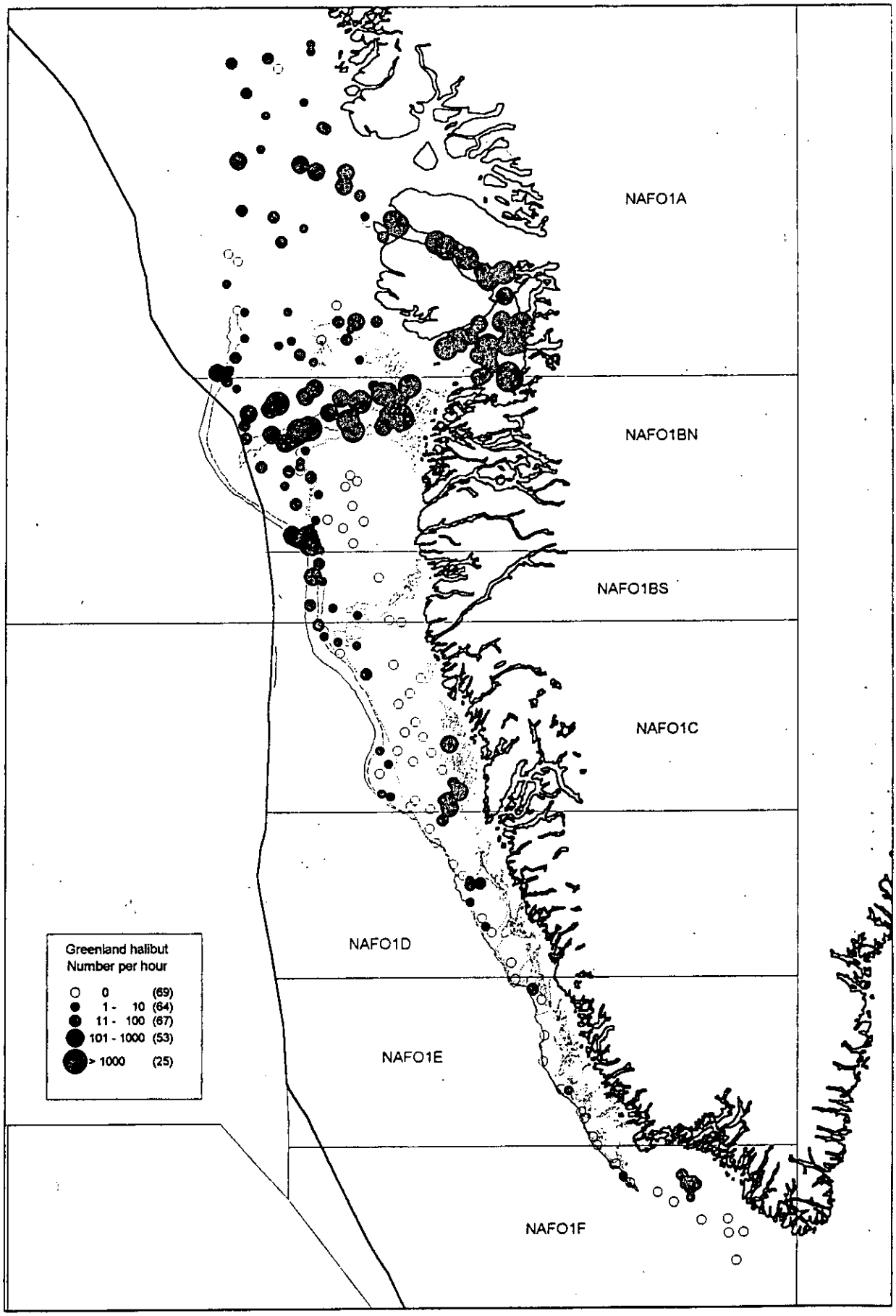
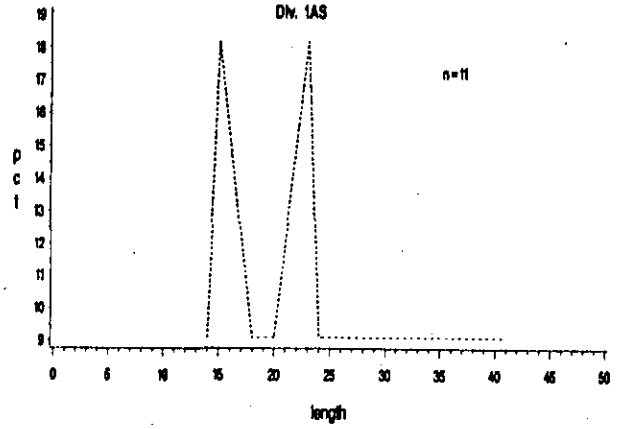
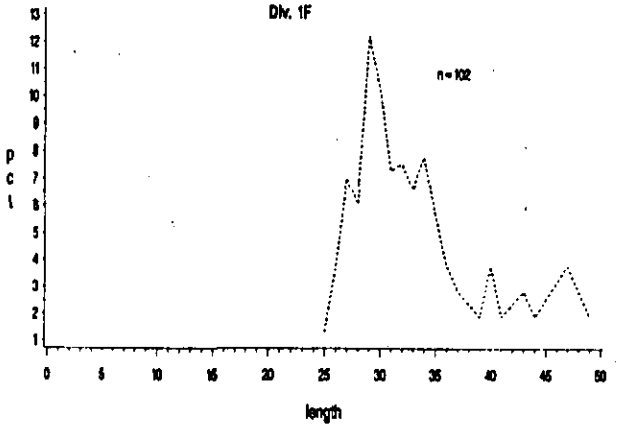
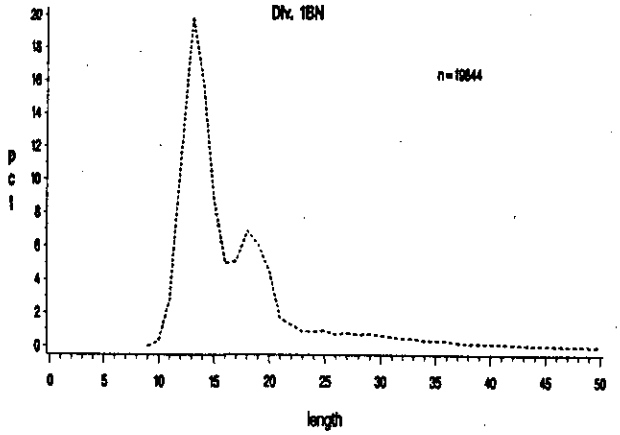


Fig. 8. Distribution of survey catches (number/hour) of Greenland halibut (all hauls). The midline against Canada and the 200, 400, 600 m depth contour lines are shown.







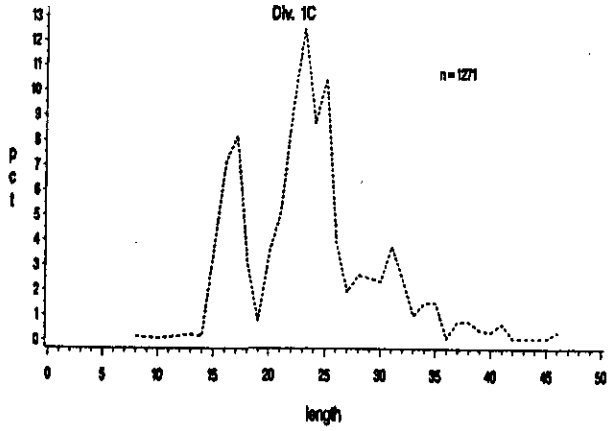
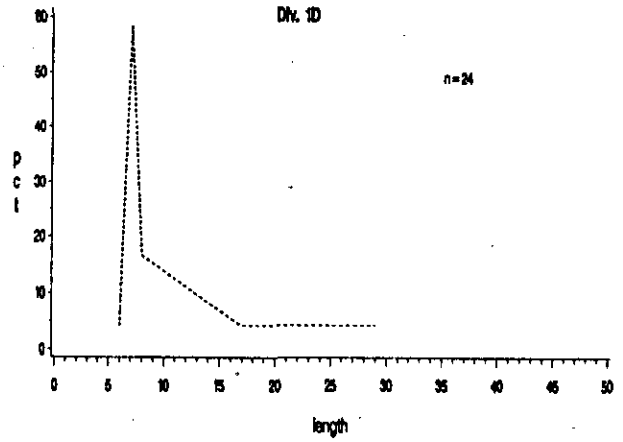
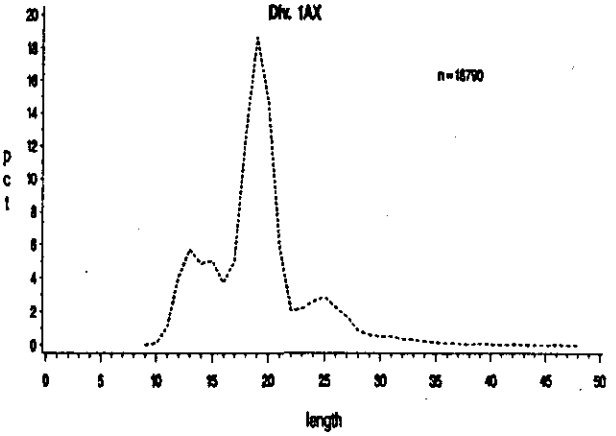
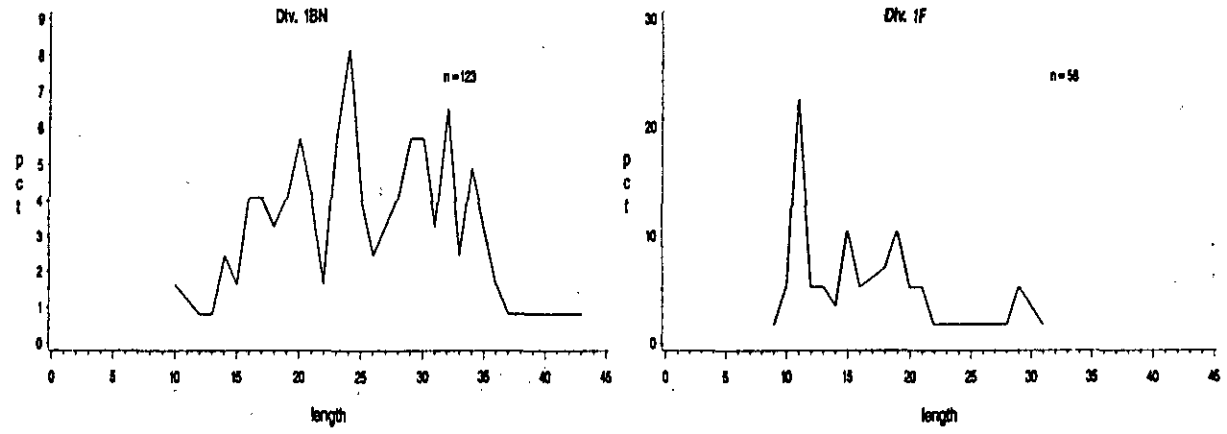
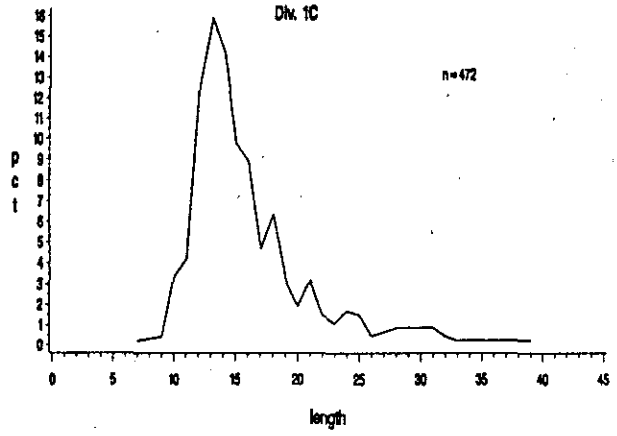


Fig. 9. Length distribution of Greenland halibut by NAFO Divisions. Only 2 observations from Div. 1E. Div. 1AX is Disko Bay.









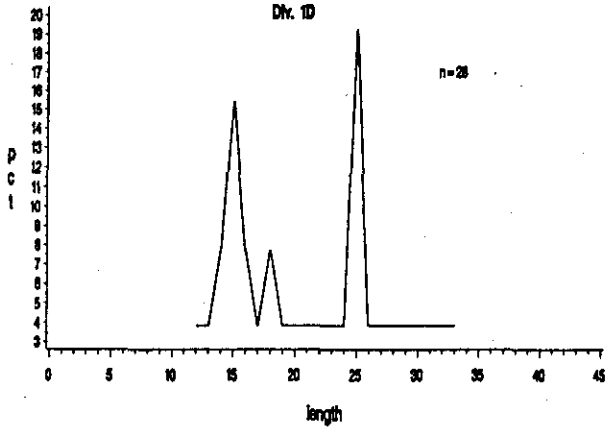
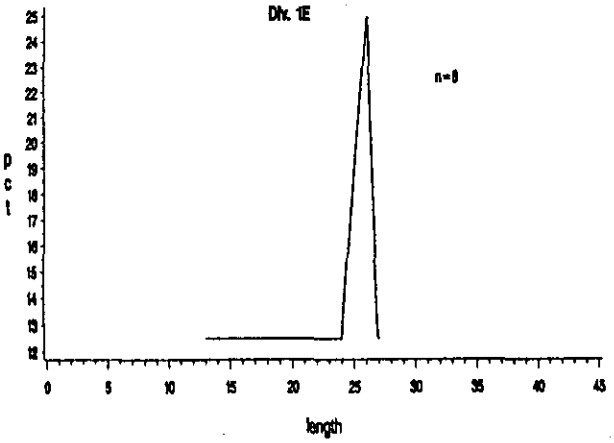
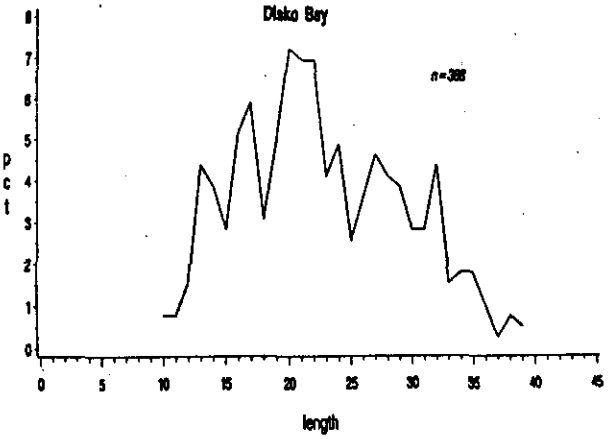


Fig. 10. Length distribution of American plaice by NAFO Divisions. Only 4 observations (12-29 cm) from Div. 1A.





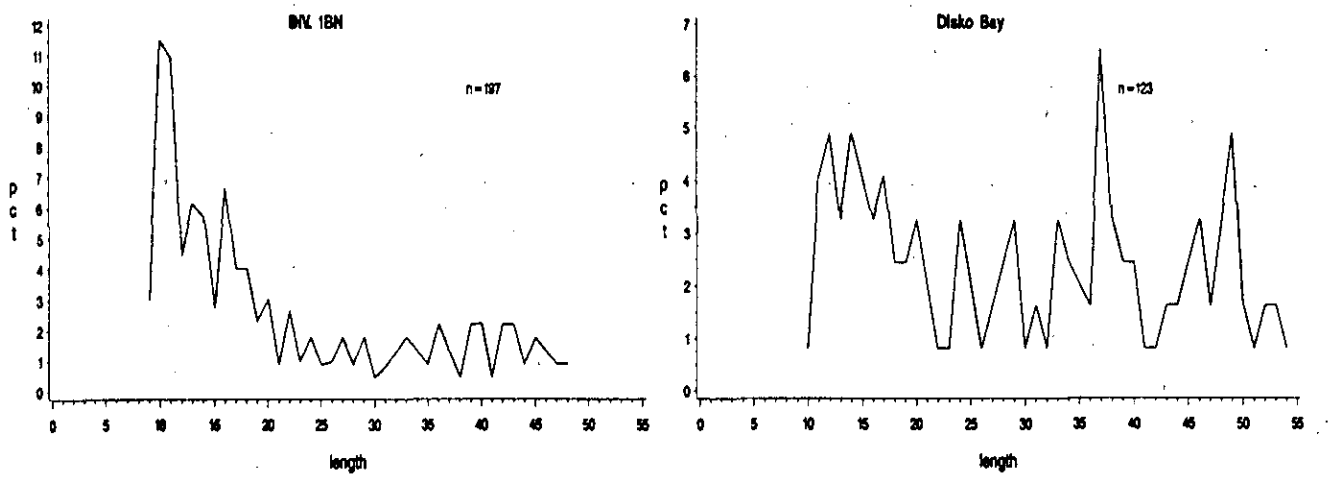


Fig. 11. Length distribution of skate by NAFO Divisions. Only few observations from the other Divisions.