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By-catch of Redfish and Greenland halibut in the Shrimp Fishery off West Greenland, 1988

by

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1. Introduction

The commercial fishery for shrimp at West Greenland has increased recently to a level of about 60,000 tons (Carlsson, 1988). The increase has occurred on the traditional offshore fishing grounds south of 71°N as well as on the newly exploited areas north of 71°N. Large quantities of juvenile redfish (*Sebastes spp.*) and Greenland halibut (*Reinhardtius hippoglossoides* Walb.) are being caught in the small-mesh shrimp trawls and discarded at sea (Riget et al. 1988).

This paper provides information on the by-catch of redfish and Greenland halibut during a stratified-random shrimp survey with the commercial shrimp trawler M/T "Elias Kleist" in Subarea 1, July 1988. Biomass and abundance estimates for the by-catch species in the survey area were calculated. An estimate of the total by-catch of redfish and Greenland halibut in the shrimp fishery off West Greenland in 1988 is given.

The by-catch is compared with earlier by-catch investigations in Subarea 1 and with the by-catch in 1988 as stated by the commercial Greenland shrimp trawlers.

2. Material and Methods

2.1 Area of investigation

West Greenland has been stratified into 6 strata (Fig. 1) taken into regard the locations of the shrimp fishing grounds and the management areas.

Stratum 0 : Northwest:
north of 71 00'N lat.
management areas : 1A NV1 and 1ANV2

Stratum 1 : Disko Bay
north of 68°00'N lat., east of 53°45'W long.

Stratum 2 : North of St. Hellefisk Bank
north of 68°00'N lat., west of 53°45'W long.
management areas : 1ASV, 1ASE, 1ANVO, 1ANE, 1BNV 1BNE.

Stratum 3 : West of St. Hellefisk Bank
north of 66°15'N lat., south of 68°00'N lat.
management area : 1BS

Stratum 4 : South of St. Hellefisk Bank
north of 64°15'N lat , south of 66°15'N lat.
management area : 1C

Stratum 5 : Southwest Greenland
south of 64°15'N lat.
management areas : 1D, 1E, 1F.

2.2 By-catch data

Catch data from the stratified-random shrimp survey with the commercial shrimp trawler M/T "Elias Kleist", July 1988 were analysed. The survey covered the offshore shrimp fishing grounds in Subarea 1 from 64°N to 72°30'N. In a total of 140 trawl-hauls the weight of shrimps and by-catched species were recorded. For most of the hauls length measurements to the nearest centimeter below of the by-catched redfish and Greenland halibut were taken. Biomass estimations of redfish and Greenland halibut has been calculated by stratified-random sampling (Cochran 1977) using the same stratification as for the calculation of shrimp biomass in the surveyed area. Information on stratification schemes, survey methods and gear specifications for the shrimp survey is given in Kanneworff and Carlsson (1989).

3. Results

3.1 M/T "Elias Kleist" shrimp survey, July 1988

The mean catch of shrimp (kg), redfish (kg,number) and Greenland halibut (kg,number) per hour trawling by stratum and depth zone is given in Table 1.

Mean catches of shrimp per hour are highest in stratum 4 (150-200) (729.4), but very similar between stratum 2-4 and somewhat lower in stratum 0.

The highest number of small redfish per hour trawling is caught in stratum 3 (201-400). Large numbers are also seen in stratum 2 (201-400), stratum 2 and 3 (401-600). In stratum 0 few redfish were taken.

The highest number of small Greenland halibut per hour trawling are caught in stratum 2 (401-600). Large numbers are also seen in stratum 0 (201-600),2 (201-400) and 3 (201-600).

Length distributions of redfish by strata are shown in Fig. 2. In the length distributions there is a peak at a signe about 14 cm for all strata. In stratum 2,3 and 4 a peak at a size of about 7 cm is also seen. Mean lengths of redfish by stratum and depth zone are given in Table 1. It appears that the smallest redfish are caught in depth zone 150-200 meters.

Length distributions of Greenland halibut by strata are shown in Fig. 3. In the length distributions there are peaks at sizes about 11 and 18 cm for all strata. In stratum 0,2 and 3 a peak at a size of about 25 cm is also seen. Mean lenghts of Greenland halibut by stratum and depth zone are given in Table 3. It appears as for redfish that the smaller Greenland halibut are caught at lower depths.

The mean number of redfish and Greenland halibut per kg shrimp caught during the survey with "Elias Kleist" has been calculated as the total number of fish caught in a stratum divided by the total catch of shrimp (Table 4). From table 4 it appears that the mean number of redfish per kg shrimp is highest in stratum 3 (6.7) and decreases in a northerly direction. The opposite picture is seen for Greenland halibut where the highest number per kg shrimp is taken in stratum 0 (2.4).

Results from biomass calculations for redfish and Greenland halibut, based on the shrimp survey stratification, are presented in Tables 5-8. The total biomasses (tons) of redfish and Greenland halibut in the surveyed area have been calculated to:

	Redfish	Greenland halibut
Northwest (Stratum 0)	2820(+/- 76%)	5654(+/- 60%)
West (Stratum 2-4)	19922(+/- 56%)	8254(+/- 23%)
Total	22742	13904

The average weight of a by-caught redfish and Greenland halibut is estimated to 0.030 kg and 0.060 respectively (Table 1). The abundance of redfish and Greenland halibut, in the area covered by "Elias Kleist", therefore can be estimated to about 750 mill. redfish and 230 mill. Greenland halibut.

3.2 The commercial shrimp fishery and estimated by-catch for 1988

The total offshore catch of shrimp off West Greenland in 1988, reported by vessels above 80 GRT, was 40,643 tons. Split into strata the following figures were obtained:

Stratum	0	(1)	2	3	4	5
Catch in tons	6660	8340	7938	12456	4691	558

Based on these figures and the estimated by-catches of redfish per kg shrimp during the "Elias Kleist" survey in Juli 1988 (Table 4), the total by-catch in the commercial offshore shrimp fishery 1988 (in the area covered by "Elias Kleist") is calculated to the following figures:

Stratum	0	(1)	2	3	4	5	All
Catch in mill.							
Redfish	1.3	-	27.8	83.4	7.0	-	119.5
Greenl. halibut	16.0	-	9.5	7.5	0	-	33.0

The total by number of by-catch of redfish and Greenland halibut in the commercial offshore shrimp fishery in 1988 in percentage of total abundance estimated from the "Elias Kleist" survey, is 16 % and 14 %, respectively.

4. Discussion

The high level of by-catch in the commercial offshore shrimp fishery estimated from this investigation is in agreement with ealier by-catch investigations in Subarea 1 (Riget et al. 1988).

Percentages by weight of by-catch of Redfish and Greenland halibut in the area of investigation for hauls made by the "Elias Kleist", July 1988 are 12% and 7%, respectively. The corresponding values for the commercial shrimp trawlers in 1988 are far below 1.6% (total by-catch) (Carlsson 1989).

The far highest by-catch of redfish during the "Elias Kleist" survey was taken not unexpected in stratum 3 and 2, since these areas are well known nursery grounds for redfish. However the far highest by-catch of Greenland halibut was unexpected taken on the relatively new shrimp fishing grounds in stratum 0 (northwest). The commercial by-catch of Greenland halibut in this area has been estimted to 16.0 mill. specimens, about the same level as the estimted by-catch of Greenland halibut in stratum 2+3. The length distributions of Greenland halibut caught in stratum 0 indicate that the fish in this area is somewhat larger than fish caught in stratum 2. This could indicate that the commercial shrimp fishery in stratum 2 has an effect on the recruitment to the commercial-sized Greenland halibut stock.

The implications upon the stocks of the large discard of small redfish and Greenland halibut, as estimated from this investigation (16 % and 14%, respectively of the total biomass per year), should be further investigated in the forthcoming years, since these discard levels could have an effect upon the stocks. Especially the by-catch of Greenland halibut in the new shrimp fishing grounds north of 71°N should be followed.

5. References

Carlsson, D. M. 1989. The Shrimp Fishery in NAFO Subarea 1 in 1988. NAFO SCR Doc. 89/53.

Cochran, W. G. 1977. Sampling Techniques. 3rd ed., John Wiley & Sons, Inc.

Kanneworf, P. and Carlsson, D.M. 1989. Report on a Stratified trawl survey for shrimp (Pandalus borealis) in NAFO SA0+1 in July 1988. NAFO SCR Doc. 89/40.

Riget, F.,J. Boje and K. Lehmann 1988. By-catches of Greenland Halibut and Redfish in the Shrimp Fishery at West Greenland. NAFO SCR Doc. 88/12.

Table 1 Mean catch of shrimp (kg), redfish (kg,number) and Greenland halibut (kg,number) per hour trawling by stratum and depth zone from shrimp survey with M/T "Elias Kleist", July 1988.

	DEPTH											
	150-200			201-400			401-600			ALL		
	KG SHRIMP PER HOUR			KG SHRIMP PER HOUR			KG SHRIMP PER HOUR			KG SHRIMP PER HOUR		
	N	MEAN	STD	N	MEAN	STD	N	MEAN	STD	N	MEAN	STD
STRATUM												
0	.	.	.	13	95.7	127.2	2	302.3	137.8	15	123.2	143.2
2	2	1.5	0.9	36	404.2	515.6	6	305.0	208.0	44	372.4	478.8
3	4	3.7	4.0	15	505.4	489.1	6	251.8	262.7	25	384.2	424.3
4	4	729.4	1457.5	9	173.6	349.3	4	340.7	457.8	17	343.7	743.0
ALL	10	293.5	921.3	73	341.6	458.6	18	294.9	268.9	101	328.5	490.4

	DEPTH											
	150-200			201-400			401-600			ALL		
	KG REDFISH PER HOUR			KG REDFISH PER HOUR			KG REDFISH PER HOUR			KG REDFISH PER HOUR		
	N	MEAN	STD	N	MEAN	STD	N	MEAN	STD	N	MEAN	STD
STRATUM												
0	.	.	.	13	0.7	1	2	5.1	7	15	1.3	3
2	2	4.0	6	36	31.7	48	6	43.4	37	44	32.0	46
3	4	2.3	4	15	49.8	47	6	32.8	32	25	38.1	43
4	4	5.1	4	9	148.0	339	4	49.1	68	17	91.1	250
ALL	10	3.7	4	73	44.2	127	18	36.9	41	101	38.9	110

	DEPTH											
	150-200			201-400			401-600			ALL		
	NO REDFISH PER HOUR			NO REDFISH PER HOUR			NO REDFISH PER HOUR			NO REDFISH PER HOUR		
	N	MEAN	STD	N	MEAN	STD	N	MEAN	STD	N	MEAN	STD
STRATUM												
0	.	.	.	13	5.0	13.6	2	104.8	148.2	15	18.3	54.4
2	2	476.2	673.4	36	1276.8	1902.4	6	2972.4	3671.1	44	1471.6	2217.1
3	4	291.5	495.7	15	3588.2	3603.1	6	623.7	917.1	25	2349.2	3191.9
4	4	243.8	268.3	9	782.7	1784.3	4	134.7	107.9	17	492.8	1302.2
ALL	10	309.4	405.2	73	1461.8	2457.8	18	1240.2	2418.0	101	1308.2	2340.1

	DEPTH											
	150-200			201-400			401-600			ALL		
	KG GRL HAL PER HOUR			KG GRL HAL PER HOUR			KG GRL HAL PER HOUR			KG GRL HAL PER HOUR		
	N	MEAN	STD	N	MEAN	STD	N	MEAN	STD	N	MEAN	STD
STRATUM												
0	.	.	.	13	20.5	20.7	2	58.8	9.4	15	25.6	23.6
2	2	0.4	0.5	36	26.7	32.3	6	54.5	34.4	44	29.3	33.5
3	4	0.9	1.4	15	15.0	26.4	6	56.4	22.1	25	22.7	30.1
4	4	0.3	0.4	9	0.8	1.1	4	25.3	21.1	17	6.4	14.2
ALL	10	0.6	0.9	73	20.0	28.1	18	49.1	27.4	101	23.3	29.6

	DEPTH											
	150-200			201-400			401-600			ALL		
	NO GRL HAL PER HOUR			NO GRL HAL PER HOUR			NO GRL HAL PER HOUR			NO GRL HAL PER HOUR		
	N	MEAN	STD	N	MEAN	STD	N	MEAN	STD	N	MEAN	STD
STRATUM												
0	.	.	.	13	254.9	343.9	2	579.1	83.1	15	298.2	338.9
2	2	25.4	22.5	36	555.8	673.5	6	1258.5	905.4	44	827.5	735.7
3	4	5.4	5.5	15	190.7	317.1	6	629.1	902.6	25	286.2	525.6
4	4	1.7	2.0	9	2.2	2.1	4	60.4	77.8	17	15.8	42.3
ALL	10	7.9	12.5	73	358.9	550.3	18	707.0	831.8	101	386.2	607.5

Table 2 Mean length of redfish caught during the shrimp survey with M/T "Elias Kleist", July 1988, by stratum and depth zone.

	DEPTH		
	150-200	201-400	401-600
	LENGTH CM	LENGTH CM	LENGTH CM
STRATUM	MEAN	MEAN	MEAN
0	.	14.4	13.6
2	.	11.1	14.8
3	.	9.3	17.9
4	7.6	14.6	20.4

Table 3 Mean length of Greenland halibut caught during the shrimp survey with M/T "Elias Kleist", July 1988, by stratum and depth zone.

	DEPTH		
	150-200	201-400	401-600
	LENGTH CM	LENGTH CM	LENGTH CM
STRATUM	MEAN	MEAN	MEAN
0	.	20.3	20.5
2	13.0	15.0	18.3
3	.	22.9	32.5
4	.	48.0	35.5

Table 4 Mean number of redfish and Greenland halibut per kg shrimp caught during the shrimp survey with M/T "Elias Kleist", July 1988.

	STRATUM			
	0	2	3	4
	MEAN	MEAN	MEAN	MEAN
GRL HALIBUT PER KG SHRIMP	2.4	1.2	0.6	0.0
REDFISH PER KG SHRIMP	0.2	3.5	6.7	1.5

Table 5 Calculated biomass of redfish in region northwest (stratum 0) by strata from stratified random survey with M/T "Elias Kleist", 1988.

BIOMASS OF REDFISH IN STRATA

REGION NORTHWEST

		STRBIOM					
		TONS	HAULS	STD	STDERR	MIN	MAX
STRATUM	SQKM						
AREA I	3649	0.00	4	0.00	0.00	0	0
AREA II	367	2.22	3	3.85	2.22	0	7
AREA III	2248	314.39	5	600.01	268.33	0	1377
AREA IV	1160	2.49	2	3.51	2.49	0	5
AREA V	11210	41.28	6	101.13	41.28	0	248
AREA VI	22267	2459.54	11	3424.29	1032.46	0	9060

Table 6 Calculated biomass of Greenland halibut in region northwest (stratum 0) by strata from stratified random survey with M/T "Elias Kleist", 1988.

BIOMASS OF GREENLAND HALIBUT IN STRATA

REGION NORTHWEST

		STRBIOM					
		TONS	HAULS	STD	STDERR	MIN	MAX
STRATUM	SQKM						
AREA I	3649	282.44	4	281.10	140.55	32	615
AREA II	367	24.19	3	37.32	21.54	0	67
AREA III	2248	837.27	5	563.00	251.78	0	1408
AREA IV	1160	5.25	2	7.43	5.25	0	11
AREA V	11210	1672.01	6	1819.82	742.94	0	4117
AREA VI	22267	2833.61	11	4876.80	1470.41	0	17225

Table 7 Calculated biomass of redfish in region west (stratum 2-4) by strata from stratified random survey with M/T "Elias Kleist", 1988.

REGION WEST

STRATUM	SQKM	STRBIOM TONS	HAULS	STD	STDERR	MIN	MAX
AREA A, 150-200 M	2321	0.00	3	0.00	0.00	0	0
AREA A, 200-300 M	5213	31.03	6	76.00	31.03	0	186
AREA A, 300-400 M	9763	3381.76	15	5133.53	1325.47	0	20102
AREA A, 400-600 M	956	962.01	2	78.88	55.78	906	1018
AREA B, 150-200 M	1542	0.00	4	0.00	0.00	0	0
AREA B, 200-300 M	2477	18.70	3	17.18	9.92	0	34
AREA B, 300-400 M	1450	506.15	2	354.28	250.52	256	757
AREA B, 400-600 M	421	88.12	2	56.54	39.98	48	128
AREA C, 150-200 M	2234	52.48	3	80.53	46.49	0	145
AREA C, 200-300 M	5470	1082.08	9	1323.32	441.11	0	3297
AREA C, 300-400 M	3909	3245.68	3	843.54	487.02	2646	4210
AREA C, 400-600 M	4122	947.90	6	798.19	325.86	139	2210
AREA D, 150-200 M	4204	86.24	7	116.54	44.05	0	303
AREA D, 200-300 M	1736	163.27	3	127.68	73.72	17	251
AREA D, 300-400 M	745	574.46	2	556.43	393.46	181	968
AREA D, 400-600 M	1915	507.64	3	543.73	313.92	173	1135
AREA E, 150-200 M	2268	60.83	4	102.75	51.38	0	214
AREA E, 200-300 M	4032	5559.80	7	13750.99	5197.38	59	36737
AREA E, 300-400 M	1957	1664.64	3	1034.80	597.44	526	2548
AREA E, 400-600 M	2762	991.10	4	1381.39	690.69	0	3017

Table 8 Calculated biomass of Greenland halibut in region west (stratum 2-4) by strata from stratified random survey with M/T "Elias Kleist", 1988.

REGION WEST

STRATUM	SQKM	STRBIOM TONS	HAULS	STD	STDERR	MIN	MAX
AREA A, 150-200 M	2321	0.00	3	0.00	0.00	0	0
AREA A, 200-300 M	5213	552.52	8	693.67	245.25	0	1946
AREA A, 300-400 M	9763	2088.96	15	2240.21	578.42	76	7562
AREA A, 400-600 M	956	190.02	2	56.06	39.64	150	230
AREA B, 150-200 M	1542	3.25	3	5.64	3.25	0	10
AREA B, 200-300 M	2477	71.59	3	80.62	46.54	11	16
AREA B, 300-400 M	1450	457.91	2	47.64	33.68	424	492
AREA B, 400-600 M	421	125.58	2	24.03	16.99	109	143
AREA C, 150-200 M	2234	4.66	3	6.62	3.82	0	12
AREA C, 200-300 M	5470	214.31	8	318.72	112.68	30	989
AREA C, 300-400 M	3909	707.29	3	659.11	380.54	0	1304
AREA C, 400-600 M	4122	2141.93	6	865.88	353.49	1268	3693
AREA D, 150-200 M	4204	16.91	7	38.79	14.66	0	104
AREA D, 200-300 M	1736	19.05	2	3.89	2.75	16	22
AREA D, 300-400 M	745	334.05	2	296.28	209.50	125	544
AREA D, 400-600 M	1915	794.07	3	519.85	300.13	282	1321
AREA E, 150-200 M	2268	9.71	4	19.41	9.71	0	39
AREA E, 200-300 M	4032	28.66	7	32.63	12.33	0	80
AREA E, 300-400 M	1957	20.46	3	35.44	20.46	0	61
AREA E, 400-600 M	2762	471.64	4	386.11	193.05	0	887

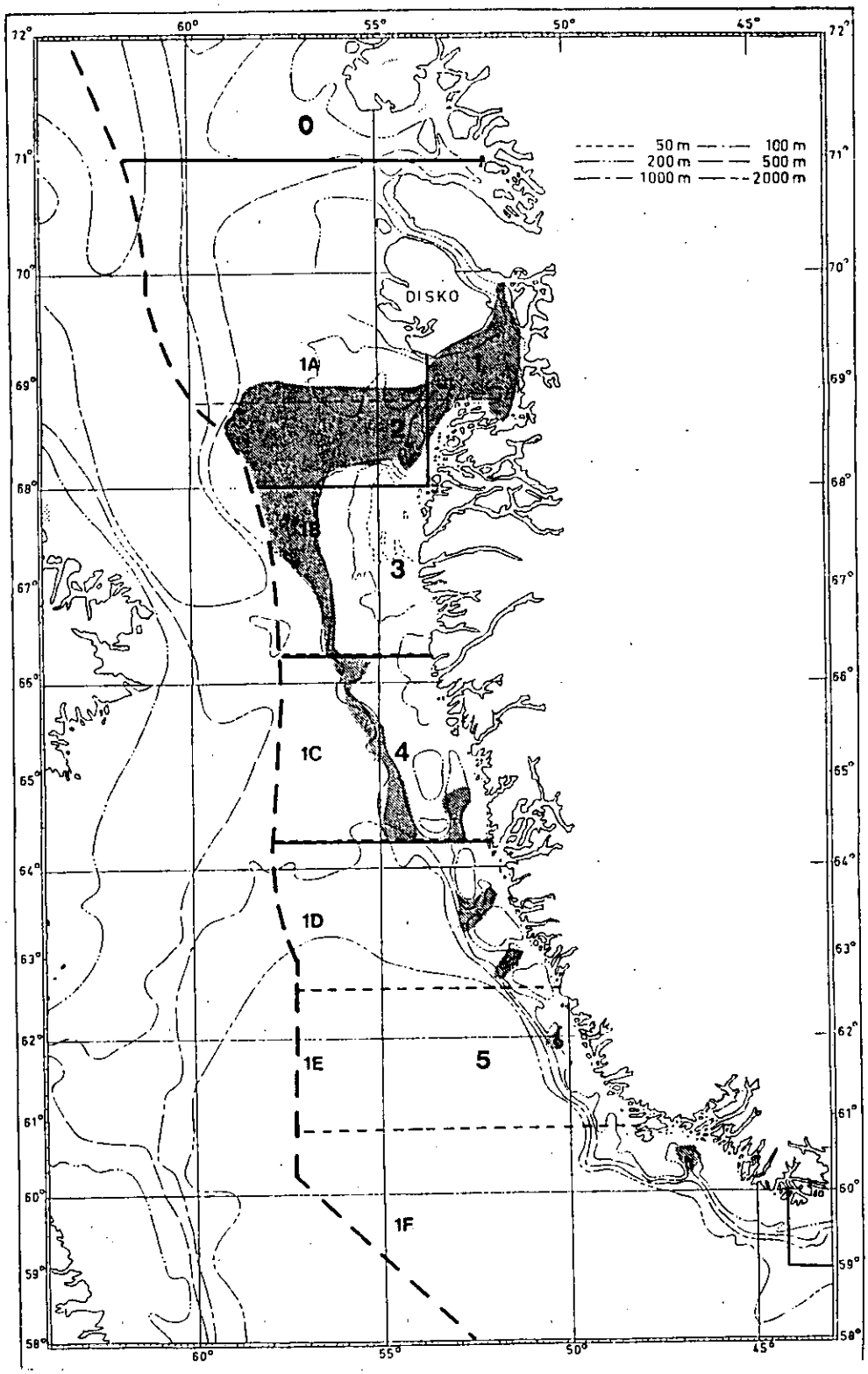

Fig. 1 The shrimp fishing grounds off West Greenland (hatched area) and the stratification of the area (solid lines) marked by figures 0-5. NAFO Divisions are shown by dashed lines.

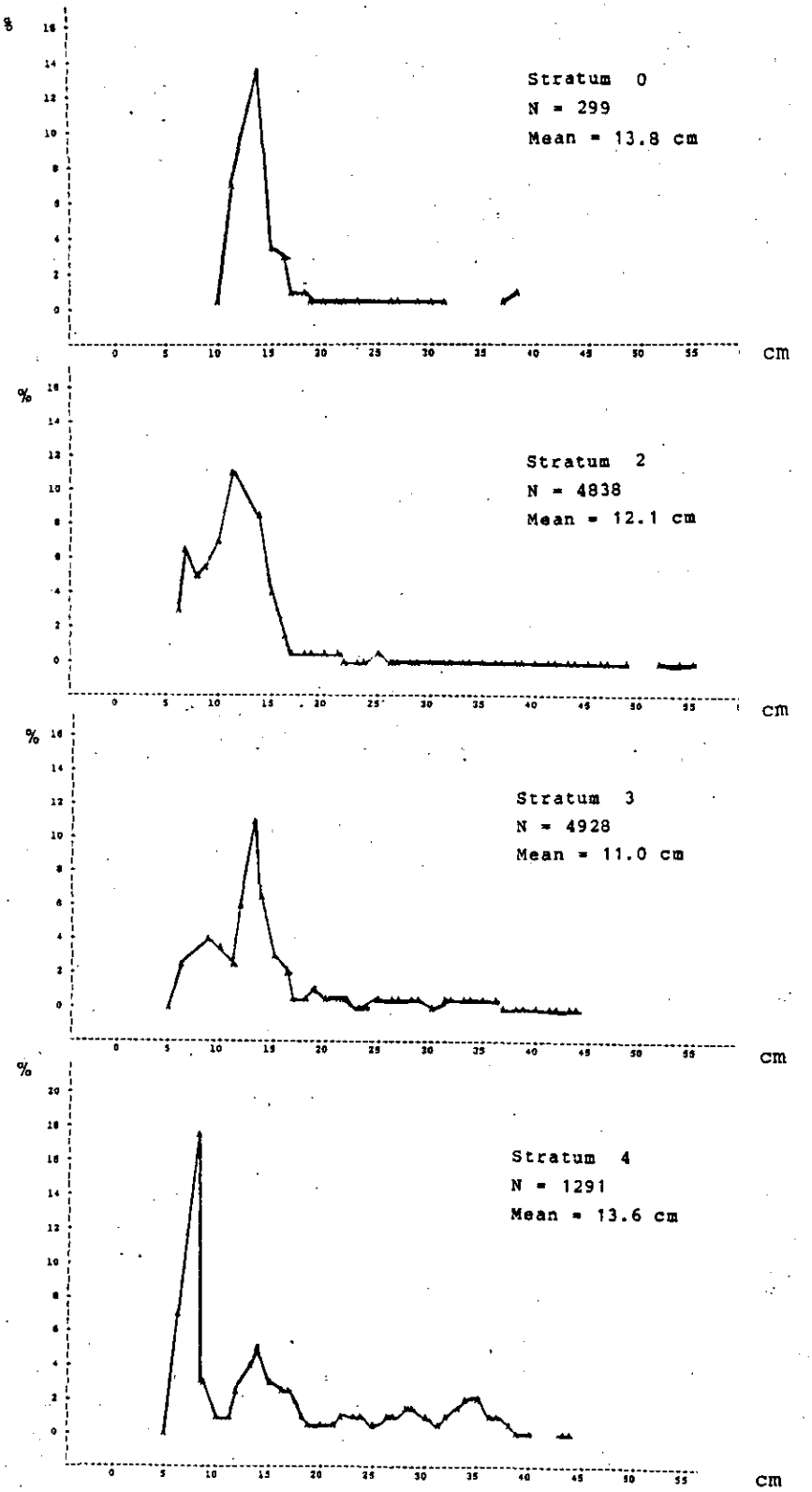

Fig. 2 Length distribution of redfish caught in the shrimp survey with M/T "Elias Kleist", July 1988, by stratum.

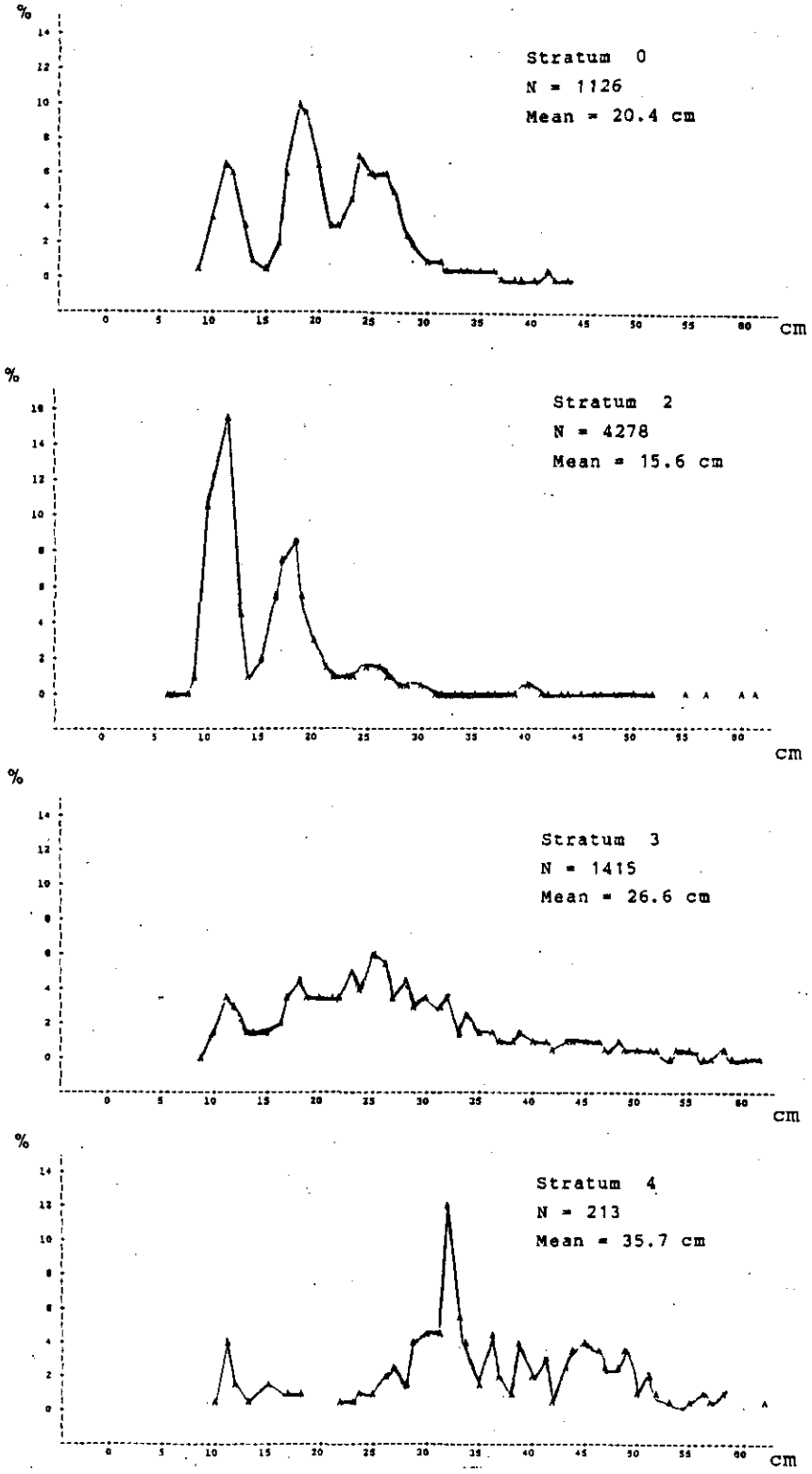

Fig. 3 Length distributions of Greenland halibut caught in the shrimp survey with M/T "Elias Kleist", July 1988, by stratum.