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By-Catches in the Shrimp Fishery at West Greenland

by

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Introduction.

An catch of about 50.000 tons shrimp (*Pandalus borealis*) hans been taken anually at West Greenland since 1986 (Sigstad *et al.* 1995). Large quantities of juvenile redfish (*Sebastes spp.*), Greenland halibut (*Reinhardtius hippoglossoides*) and other groundfish are being caught in the small-mesh shimp trawls. Research trawl hauls for shrimp by the research vessel "Paamiut" are used in order to estimate of the by-catch in 1994 of redfish, Greenland halibut and other important species in the fishery for shrimp in NAFO division 1 south of 70°N. Comparisons are made of these by-catch estimates with those stated by a commercial Greenland shrimp trawler as well as with those obtained from previous investigations in the area.

Material and Methods.

Area of investigation.

The shrimp fishing grounds of West Greenland are marked on fig. 1 as shown by Sigstad *et al.* 1995.

By-catch data.

During the period 1989-1995 the Greenland Institute of Naturcal Resources carried out considerable number of research hauls for shrimp in Division 1. Among these data are 475 hauls selected for further analysis according to certain criteria:

1) Only hauls from the shrimp fishing grounds or in the immediare viciniry of these have been used.

2) Only hauls on mean depth in the interval 180-450 m were incluted.

The reseach hauls was conducted with the commercial stern trawler M/tr Paamit (722 GRT). Mean towing speed was 2.5 knots. Trawl operations were only performed during daytime. The trawl used was a Skjervoy 3000 with bobbin gear and a double-bag . The trawl doors used were of the type 'Perfekt'. A codend with a mesh size of 44mm were used in surveys from 1989 until 1992. In 1993 it was replaced by a codend with 20mm strectched mesh. As the mesh sises used in the commercial fishery are 44mm, research vessel data from 1993-1995 are adjusted in accordance with a series of 60 parallel hauls performed with the to mesh sizes during the survey in 1993 in order to make them comparable. No signinificant differences in catch weight are found for any species, but the catch in number of redfish <= 10 cm are significant different in the two codends, and are adjusted in according to Bech 1994 by the following equations:

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

where n = numbers of fish in 44 mm mesh, and N = numbers of fish in 20 mm mesh of the given length group.
The catch of shrimp and bycatches of fish were recordet, and in most cases length measurements were made. As the bycatches of redfish mainly consist of fish under 20 cm an identification to spicies level has not been posible, due to problems with the identification of the younger stages of the two species *Sebastes marinus* and *S. mentella*. Fish were measured as total length to nearst cm below.

By-catch from the comercial shrimpfishery are analysed by means of 20 trawl-hauls from the shrimp trawler m/t "Timmiarmiut". The weight of shrimps and length and weight of by-catched spices were recorded.

By-catch estimation.
The number of fish per kg shrimp is calculated as the total number of fish caught per NAFO division divided with the total catch of shrimp.
On the basis of total catch estimates of shrimp per strata in 1994 and number of fish per kg shrimp and mean weight of redfish and cod, by-catches are estimated for each division and raised to total by-catch by division.
In the estimation it is assumed that within the strata, shrimp and by-catch species both have a uniform distribution equal in range.

Results.

The shrimp fishery and by-catches in the fisherey.
The nominal catches of shrimp at in Subarea 1, 1990-1995 are shown in tab 1. Anual catches has varied beetween 45000-55000t without any clear trend. Because no research data exixts of by-catches in the offshore area north of 71°N, this area is excluted in the analysis. Likewise, the only inshore area incluted in the analysis is the Disko Bay. Total catches of shrimp by division in 1994 is given in tab.2. Division 1AX (Disko Bay) is the most important inshore fishing ground and has an estimated catch of 7255 tonns in 1994 (M. Andersen 1994).

"Timmiarmiut" 's hauls for shrimp.
Table 3 shows the mean catch of shrimp per hour of trawling and the mean number of redfish, Greenland halibut, cod (*Gadus morhua*), Atlantic- and spotted wolffish (*Anarhichas lupus* and *A. minor*) and American plaice (*Hippoglossoides platessoides*) per hour of trawling together with the number of fish per kg shrimp by division.
Mean cpue of shrimp is high in division 1B and 1D with 881 and 891 kg per hour of trawling in comparison with 502 kg in division 1C.
Mean cpue of redfish is considerably higher in division 1C than in 1B and 1D with values of 3493 and 1873, 1064 specimens per hour of trawling respectively. Likewise number of redfish per kg shrimp is higher in division 1C at 6.96 specimens in comparison with 2.13 and 1.19 specimens per kg shrimp in division 1B and 1D respectively. Length distributions of redfish in the three divisions are rather similar, within the range 10 - 20 cm (fig 2).

For Greenland halibut both mean cpue and number of fish per kg shrimp are higher in division 1B than in 1C and 1D. Fig. 3 shows length distributions of Greenland halibut. The same size distributions are seen in the two areas, with fish length ranring from 10cm to 40cm.
The by-catch of cod and spotted wolffish are low or nil, in all divisions. Atlantic wolffish and American plaice are found mainly in divsion 1C and 1D. The length distribution are between 20 and 50 cm and 10 and 30 respectively (figur 4 and 5).

By-catch in research hauls for shrimp.
The mean catch of shrimp per hour of trawling, the mean number of by-catched fish per hour of trawling and by-catched fish per kg shrimp are shown in Table 4 for the research trawl survey hauls.
Mean cpue of shrimp in the research vessel's hauls are highest in division 1B, and 1D and lowest in division 1AN an AS which agrees with the general pattern of shrimp catches at West Greenland. "Paamiut" has gennerally a lower catch rate of shrimp than the commercial vessel, but no striking differences are seen in the rate of by-catch, or the by-catch per kg shrimp.
There are major difference in mean cpue of Greenland halibut between divisions. In division 1B and 1AX (Disko Bay) the mean cpue are considerably higher than in the southern divisions. The same trend is seen in the mean cpue from the "Timmiamiut" data. Length distributions of Greenland halibut by division are shown in fig. 6 and it appears that small

Greenland Halibut are predominating in 1A and 1B. In the length distributions there are peaks at sizes about 11 and 18 cm. The same peaks are found in "Timmiamiut" data but not so evident. In division 1C-1E peaks are found at 15-16 cm and 25cm. In 1F are the length distributions more broad with fish length ranging from 6 cm to 40 cm.
Very high by-catch of redfish are found in division 1B and 1C while it decreases in northerly derection. From the length distribution (fig. 7) it appears that redfish from 6 to about 20 cm are predominating in the catch, similar to the distributions obtained from "Timmiamiut" 's hauls. There is an almost indical length distribution in all divisions with a distinct peak at 12 cm.
Very similar catches and length distributions between 10 cm and 40 cm of American plaice are found in all divisions (fig. 8).
As for "Timmiarmiut" the by-catches of spotted wolffish are nil or wery low in all areas. Bycatch of American wolffish are taken in the southernmost divisions. Length distributions are shown in fig 9.
Significant catches of cod are found in 1D and somewhat less in 1C and 1E. For the other divisions the bycatch of cod are nil or very low. Length distributions are shown in fig 10.

Discussion.

The highest by-catch of redfish taken in the "Pamiut" survey was not unexpected in division 1B and 1C, since thise areas are well known nursery grounds for redfish.
Based on the bycatch pr kg shrimp in the Paamiut trawl hauls and the total shrimp catch in NAFO division in 1994, the total bycatch has been calculatet to 4234 tons or 180 millions of redfish
Electrophoretic studies indicates, that redfish caught north of 67°N belongs mainly to the species *Sebastes mentella* (O. T. Igland & G. Nævdal 1995). Whith this infomation the by-catch can be devidet up in 2.279 tons of *S.mentella* caught north of 67°N and 1.955 tons of *Sebastes sp.* in the rest of the area. This figure should be compared with a total biomass of 17744 tons redfish for West Greenland as estimated in the Greenland Trawl Survey in 1994 (Bech 1994a). The level of redfish bycatch is in agreement with ealier by-catch investigations in NAFO 1 subarea made by Riget *et al.* 1988. They estimated a bycatch of 111 milions or 15,584 tons of redfish in a total shrimp catch of 49089 tons in 1988. A higher mean lengh in 1988 accounts for the weight difference.
Total by-catch of Greenland halibut in division 1A -1F is estimated to 21 millions specimens corresponding to about 1.467 tons for 1994. The northern areas Disko Fjord (division 1AX) and North of Store Hellefiske Bank (division 1B) account for catches with far the highest numbers of Greenland Halibut per kg shrimp. The total biomass for Greenland halibut in 1994 has been estimated to 17636 tons in the Greenland Trawl Survey (Bech 1995).
The by-catches of cod were estimated to 32 tons or 165 thousands of cod. American place, Atlantic and spotted wolffish in the research vessel hauls as well as in the hauls of the commercial vessel are also low, but in proportion to the severely depleted status of these stocks at West Greenland this might be significant. In recent years decreases of biomass estimates for stocks of cod, American plaice spotted wolffish vary between 73% almost 100% (Rätz 1995). As an exsample the total abundance for offshore cod at West Greenland were in 1994 estimated to only 165000 ± 141500 specimens (Bech 1994b).
An anunlly bycatch about 180 millions of redfish and 160-170 thusands of cod suggest a causality between the by-catch in shrimp fishery and the recruitment failure of thise stocks at West Greenland, however the present estimate and the 1988-estinate are both based on research vessel hauls at fixed stations, and may not be representative of a commercial fishery continuously shifting grounds for getting high catch rates. Grids is only used in a limited extend by the commercial shrimp trawlers, but the legislation on shrimp fishery in Geenland command a vessel to leave an area, if the by-catch pr haul exceeds 10%.

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Table 1. Nominal catches of shrimp in NAFO division 1, 1990 to September 1995 (H. Siegstad et al 1995).

	1990	1991	1992	1993	1994	1995*
Offshore	49478	52652	58676	52493	53693	43212
Inshore	13630	16258	20594	17843	18118	9643
Nominal catches	63108	68910	79270	70336	71811	52855

* preliminary figures

Table 2. Offshore catches and inshore (Disko Fjord) of shrimp (tons) by division in NAFO Subarea 1 in 1994 (H. Siegstad et al 1995).

Division	
1AN	837
1AS	1148
1AX	7255
1B	15644
1C	9276
1D	11213
1E	4388
1F	1942
total	51703

Table 3. Catch of shrimp and by-catches of fish by division in "Timmiarmiut"'s fishery in 1996.

Division	1B	1C	1D
No of hauls	6	8	6
Shrimp mean weight (kg)/hour trawling	881	502	891
Redfish mean number /hour trawling	1873	3493	1064
No of fish /kg shrimp	2.13	6.96	1.19
Cod Mean number /hour trawling	0.49	0.43	0.77
No of fish /kg shrimp	0.01>	0.01>	0.01>
Greenland halibut mean number /hour trawling	751.1	64.7	9.6
No of fish /kg shrimp	0.85	0.13	0.01>
Spotted Wolffish mean number /hour trawling	0	0	0
No of fish /kg shrimp	0	0	0
Atlantic wolffish mean number /hour trawling	0.23	2.95	9.59
No of fish /kg shrimp	0.01>	0.01	0.01
American plaice mean number /hour trawling	0	24.10	4.94
No of fish /kg shrimp	0	0.05	0.01

Table 4. Catch of shrimp and by-catch of fish by division in research hauls for shrimp 1989-1995.

Division	1AN	1AS	1AX	1B	1C	1D	1E	1F
No of hauls	22	22	46	202	90	65	17	11
Shrimp mean weight (kg)/hour trawling	150	174	440	523	162	422	357	508
Redfish mean number /hour trawling	15	582	38	3491	582	617	541	583
No of fish /kg shrimp	0.18	3.34	0.08	7,42	3,60	1,47	1,58	1,15
Cod Mean number /hour trawling	0.3	0.3	0	0.3	2.2	29.9	2.4	0.1
No of fish /kg shrimp	0.01>	0.01>	0	0.01>	0.01	0.10	0.01	0.01>
Greenland halibut mean number /hour trawling	76	52	320	397	29	40	46	11
No of fish /kg shrimp	0.50	0.30	0.71	0.76	0.18	0.09	0.13	0.02
Spotted Wolffish mean number /hour trawling	0	0	0	1	0.01	0.06	0	0
No of fish /kg shrimp	0	0	0	0.01>	0.01>	0.01>	0	0
Atlantic wolffish mean number /hour trawling	0	0	0.1	0.3	0.88	1.45	2.39	6.79
No of fish /kg shrimp	0	0	0.01>	0.01>	1	0.01>	0.01	0.01
American plaice mean number /hour trawling	3	1	11	14	10	23	6	6
No of fish /kg shrimp	0.02	0.01	0.02	0.03	0.06	0.05	0.02	0.01

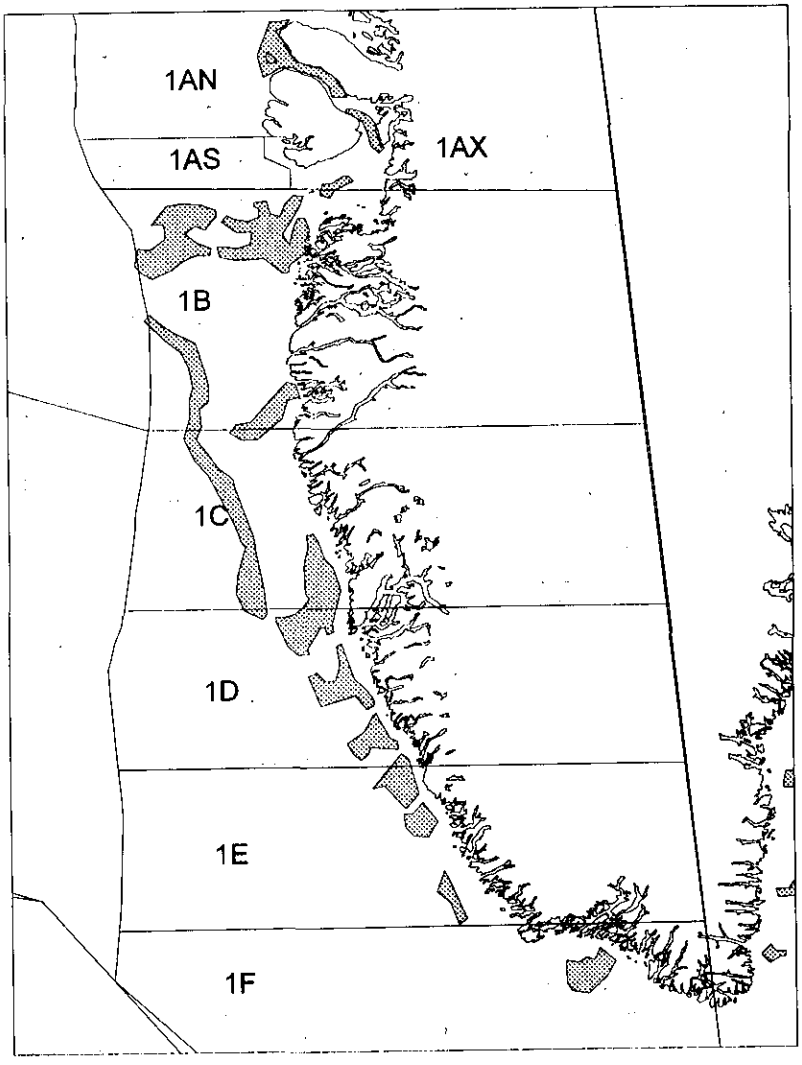


Fig. 1. The shrimp fishing grounds off West Greenland and the NAFO divisions

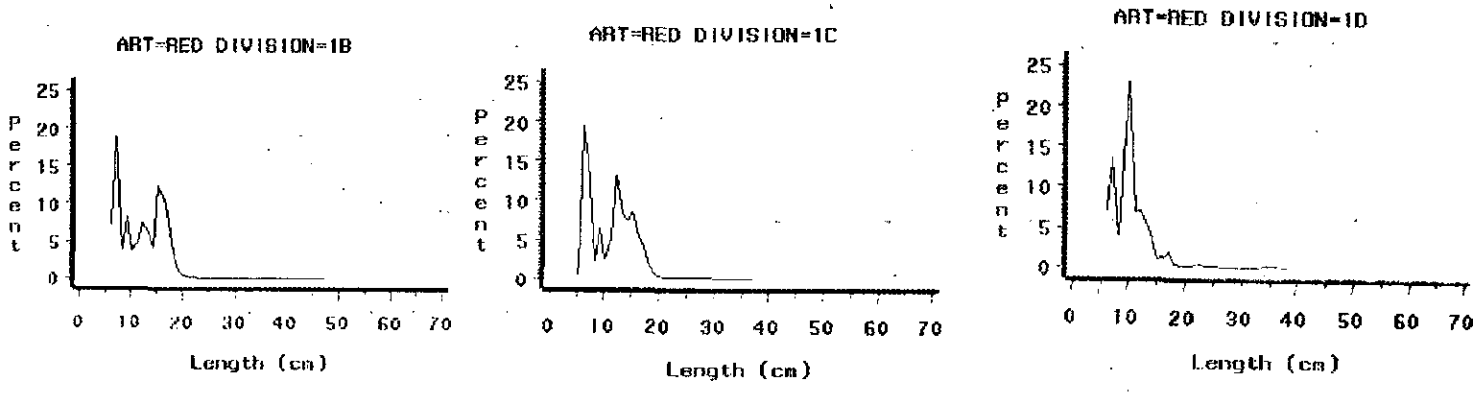


Fig.2. Length distribution of redfish from "Timmiammiut"' trawlings.

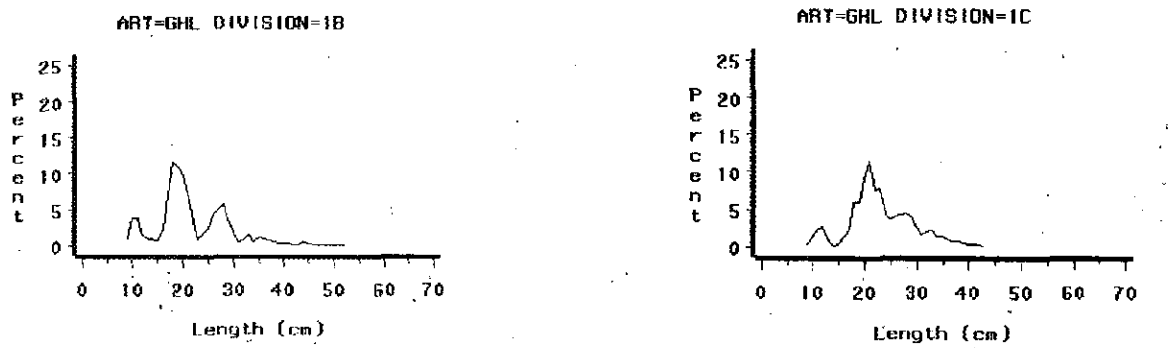


Fig.3. Length distributions of Greenland halibut from "Timmiarmiut"'s trawlings.

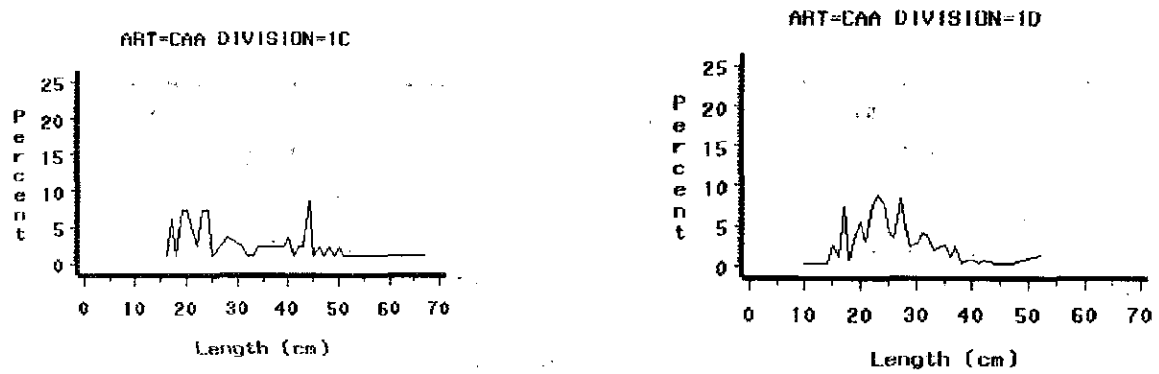


Fig.4. Length distributions of Atlantic wolffish from "Timmiarmiut"'s trawlings.

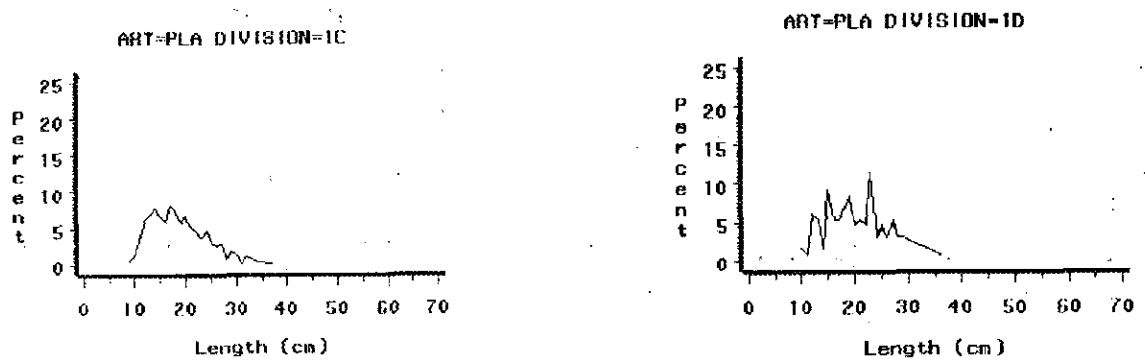
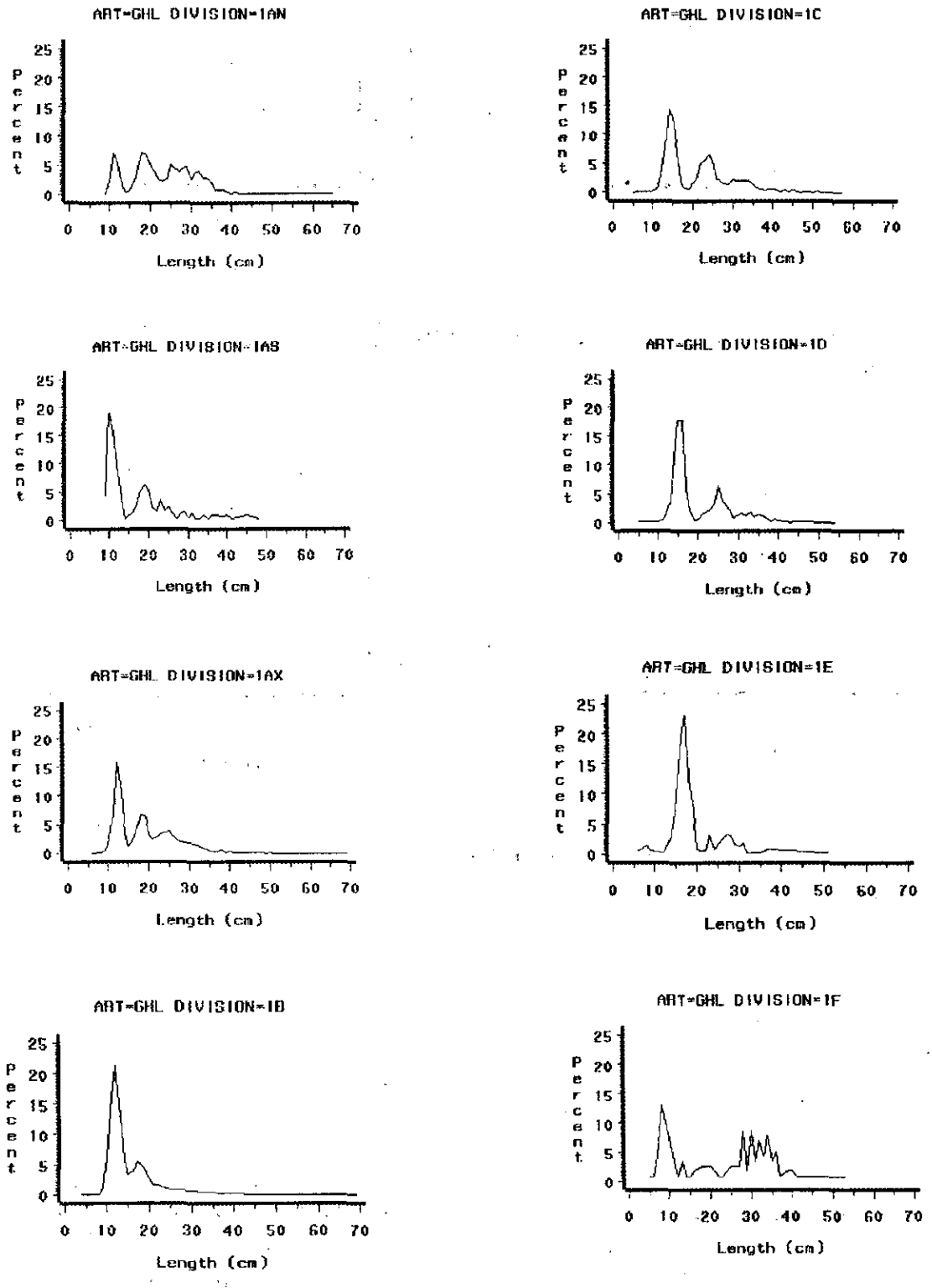
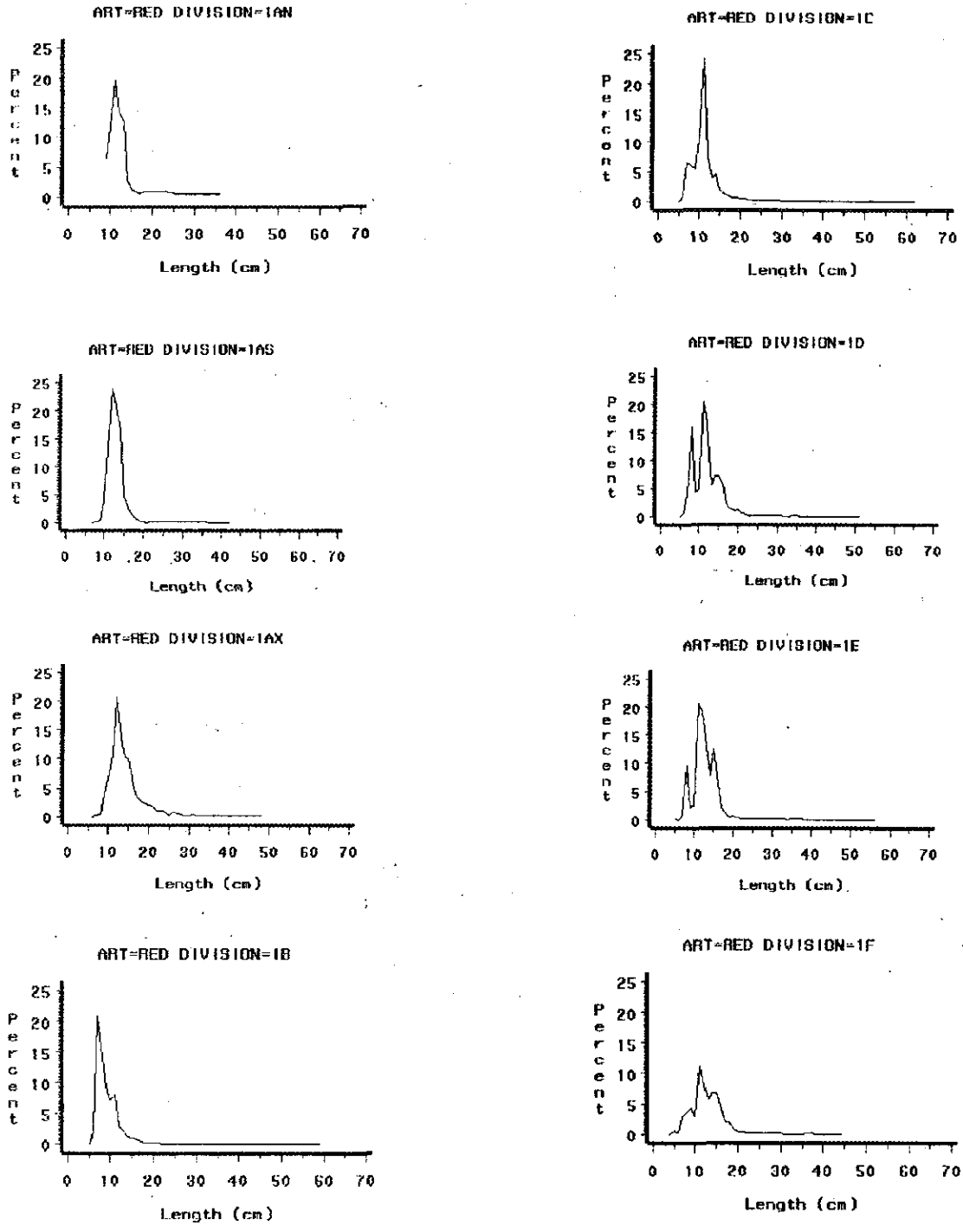


Fig.5. Length distributions of American plaice from "Timmiarmiut"'s trawlings.



Figre 6. Length distributions of greenland halibut from research trawl surveys in 1989-1995.



Figre 7. Length distributions of redfish from trawl surveys in 1989-1995

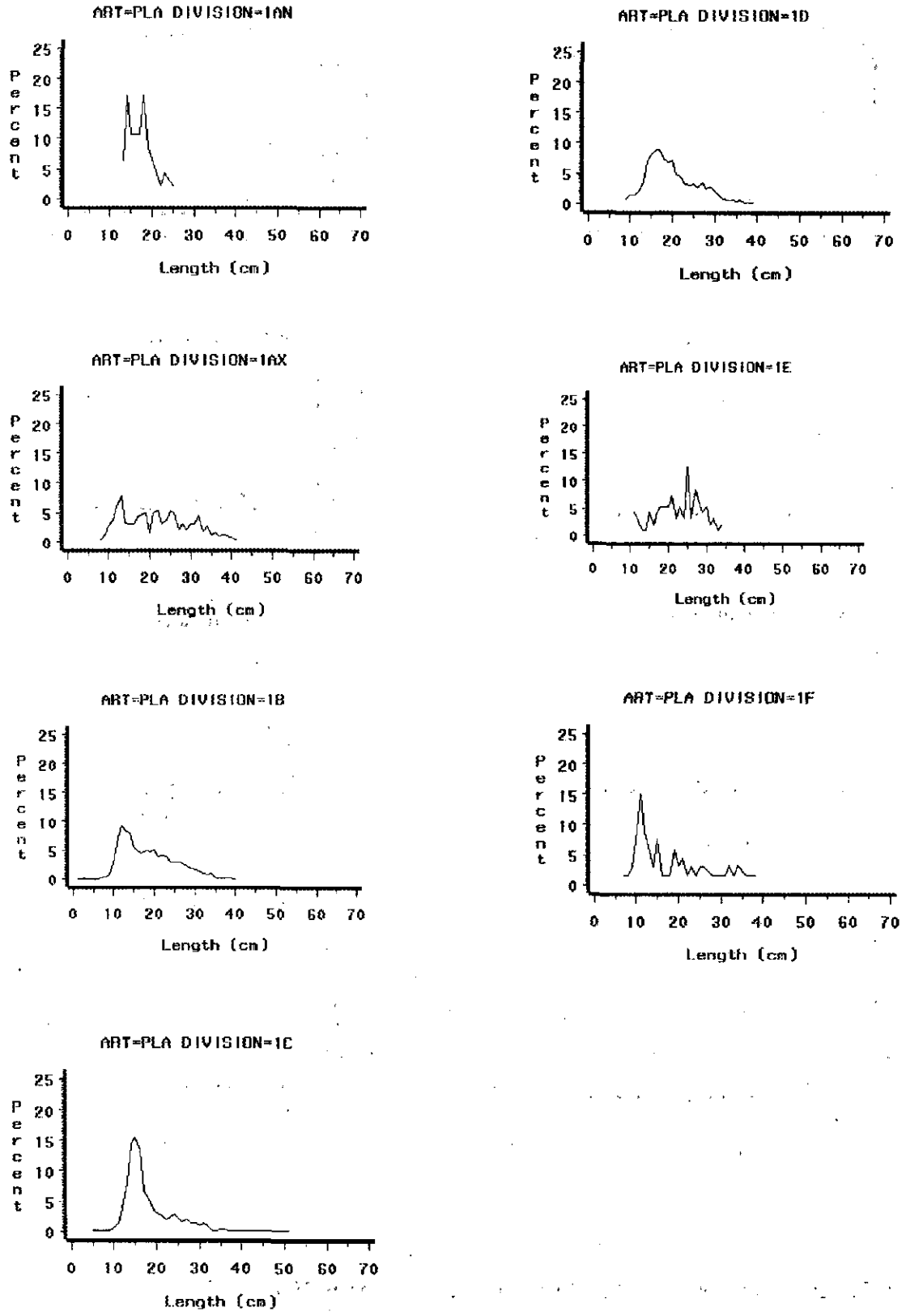


Fig. 8. Length distributions of American plaice from research trawl surveys in 1989-1995.

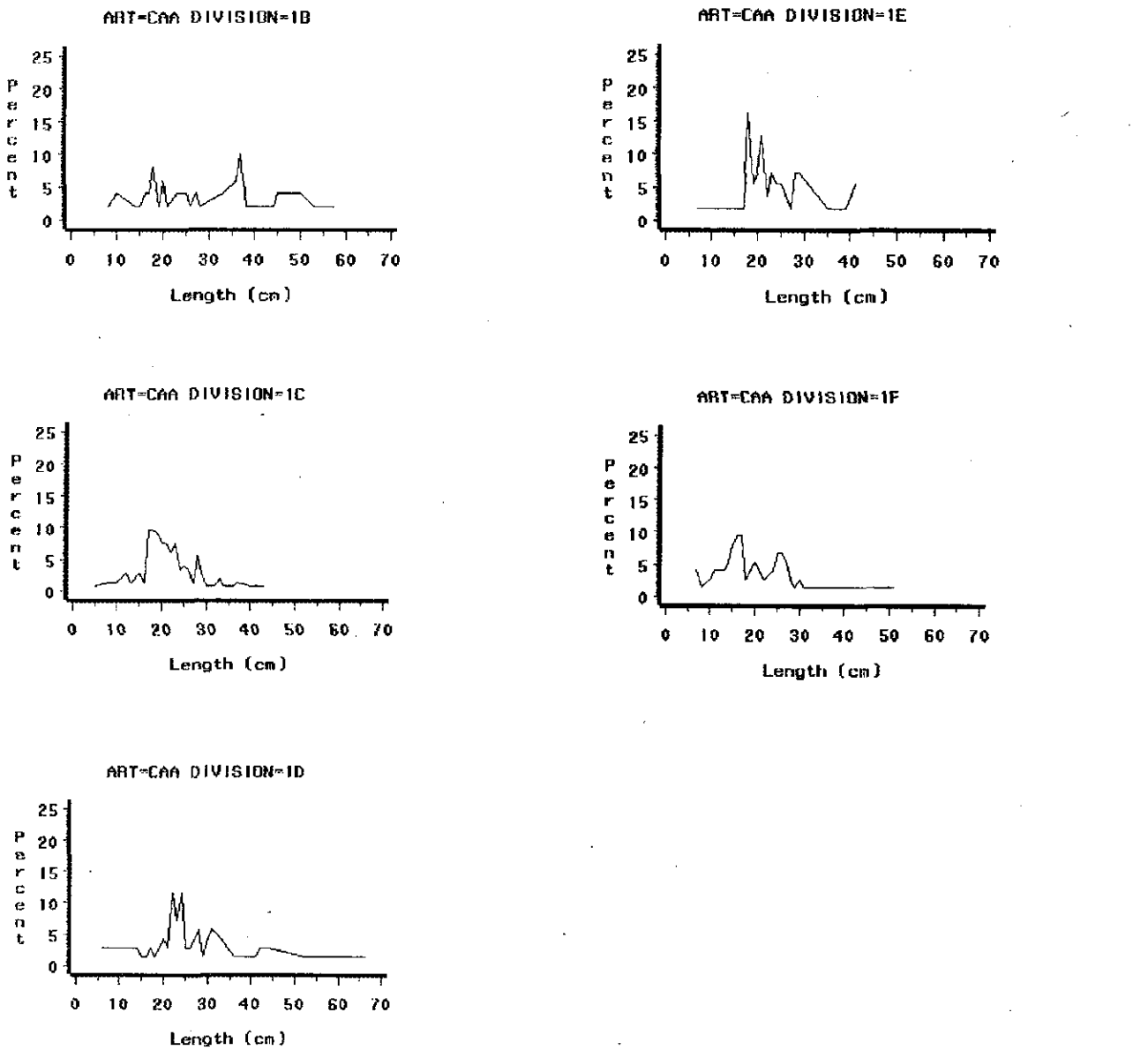


Fig. 9 Length distributions of Atlantic wolffish from research trawl surveys in 1989-1995.

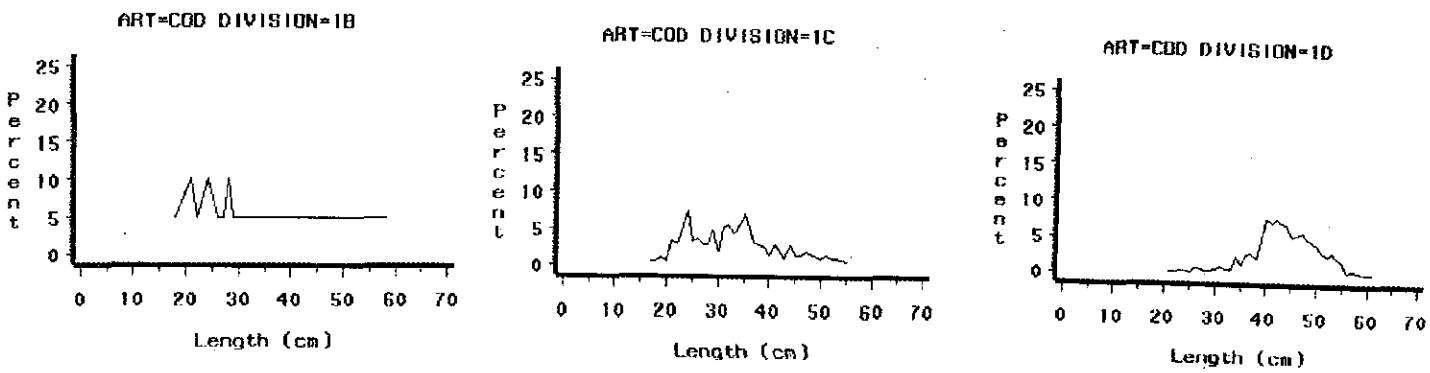


Fig.10. Length distributions of cod from research trawl surveys in 1989-1995.