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Status of the Demersal Fish Assemblage off West Greenland, 1982-94 (Divisions 1B-1F, 0-400 m)

by

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Abstract

During 1982-94, survey results indicated fundamental shifts in species composition of the demersal fish assemblage inhabiting the shelf and continental slope off West Greenland in Divisions 1B-1F down to 400m depth. These observations happened in coherence with dramatic changes in stock abundance, biomass and size structure for ecologically and economically important species. Recent decreases of biomass estimates for demersal stocks of cod, American plaice, golden redfish, Atlantic and spotted wolffish and starry skates vary between 73% and almost 100%, losses in abundance being less pronounced. Length distributions revealed that these stocks are mainly composed of small and juvenile fish at present.

The status of the demersal fish assemblage stagnates at that low level since 1990 lacking any signs of recovery. In view of their poor status and unreliable catch figures, short term recovery of the demersal stocks must be considered as unlikely and the present situation does not allow to formulate any long term prediction.

Introduction

Since 1982, the demersal fish assemblage off West Greenland has been monitored annually by German groundfish surveys. The surveys were conducted during fall and represent the only source of information about the status of the groundfish stocks inhabiting the shelf and continental slope in Divisions 1B-1F outside the 3 mile zone down to 400m depth. This paper describes the most recent status and trends in stock abundance, biomass and structure for ecologically and economically important species as derived from survey catches.

Materials and Methods

Abundance, biomass estimates and *length structures* have been derived using annual groundfish surveys covering shelf areas and the continental slope off West Greenland. Surveys commenced in 1982 and were primarily designed for the assessment of cod. Because of favourable weather and ice conditions and to avoid spawning concentrations, autumn was chosen for the time of the surveys. These were carried out by the research vessel (R/V) WALTHER HERWIG (II) throughout most of the time period, except in 1984 and 1994, when R/V ANTON DOHRN was used and she was replaced by the new R/V WALTHER HERWIG III, respectively.

The fishing gear used was a standardized 140-feet bottom trawl, its net frame rigged with heavy ground gear because of the rough nature of the fishing grounds. A small mesh liner (10mm) was used inside the cod end. The horizontal distance between wing-ends was 25m at 300m depth, the vertical net opening being 4m. In 1994, smaller Polyvalent doors (4.5m^2, 1,500kg) were used for the first time to reduce net damages due to overspread caused by bigger doors (6m^2, 1,700kg) which have been used previously. All calculations of abundance and biomass indices are based on the 'swept area' method using 22m horizontal net opening as trawl parameter, i. e. the constructional width specified by the manufacturer. The towing time was normally 30 min. at a speed of 4.5 knots. Trawl parameters are listed in Table 1. Hauls which received net damage or became hangup after less than 15 minutes were rejected. Some hauls of the 1987 and 1988 surveys were also included although their towing time had been intentionally reduced to 10 minutes because of the expected large cod catches as observed from echo sounder traces.

Fish were identified to species or lowest taxonomic level and the catch in number and weight was recorded. Redfish (>=17 cm) were separated to golden (*Sebastes marinus* L.) or beaked redfish (*Sebastes mentella* Travin), whereas juvenile redfish (<17 cm) were classified as *Sebastes spp.* due to time-consuming and difficult species indentification.Total fish lengths were measured to cm below.

The surveys were primarily designed for the assessment of cod. In order to reduce the error of abundance estimates, the subdivision of shelf areas and the continental slope into different geographic and depth strata was required due to a pronounced heterogeneity of cod distribution. The survey area was thus split into four geographic strata. Each stratum was itself subdivided into two depth strata covering the 0-200m and 201-400m zones. Figure 1 and Table 2 indicate the names of the 8 strata, their geographic boundaries, depth ranges and areas in nautical square miles (nm^2). All strata were limited at the 3 mile offshore line.

The applied strategy was to distribute the sampling effort according both to the stratum areas and to cod abundance. Consequently, fifty percent of the hauls were allocated proportionally to strata by stratum area while the other fifty percent were apportioned on the basis of a review of the historical mean cod abundance/nm^2, all hauls being randomly distributed within trawlable areas of the various strata. Non-trawlable areas are mainly located inshore. During 1982-94, 1,268 successful sets were carried out, the numbers of valid sets by year and stratum being listed in Table 3.

Stratified abundance estimates were calculated from catch-per-tow data using the stratum areas as weighting factor (Cochran, 1953; Saville, 1977). Strata with less than five valid sets were rejected from the calculation. The coefficient of catchability was set arbitrarily at 1.0, implying that estimates are merely indices of abundance and biomass. Respective confidence intervals (CI) were set at the 95% level of significance of the stratified mean.

Data of a standard haul conducted unintentionally side by side with a Greenlandic shrimp trawler during the last survey in 1994 are listed.

Results

Table 4 and 5 list abundance and biomass estimates for cod (*Gadus morhua*), American plaice (*Hipplogossoides platessoides*), golden and beaked redfish (*Sebastes marinus* and *S. mentella*), Atlantic and spotted wolffish (*Anarhichas lupus* and *A. minor*), starry skate (*Raja radiata*), others and all species aggregated to total. Trends in abundance and biomass are illustrated in Figures 2 and 3 for cod and others. Both aggregated abundance and biomass estimates are dominated by the occurrence of cod. After a decrease from 350 million individuals and 270,000 tons in 1982 to 180 million individuals and 70,000 tons in 1984, the total indices increased to the maximum values amounting to 1,300 million individuals and 690,000 tons in 1987. The following 3 years are characterized by dramatic declines to 220 million individuals and 50,000 tons in 1990. Since then, the demersal fish fauna stagnated at this low level and the most recent indices amounted to 130 million and 8,000 tons in 1994 representing an overall reduction of 90% and 99% in abundance and biomass, respectively.

During 1982-94, cod was found to be the dominant fish species. The trends in stock abundance and biomass controlled the aggretated values of the entire demersal fish assemblage. The increase in stock abundance and biomass during 1984-87 to 790 million individuals and 640,000 tons was due to the recruiting process of the year classes 1984 and 1987. Thereafter, the stock abundance and biomass collapsed by nearly 100% to indices amounting to 0.5 million and 140 tons in 1994. The most recent length structure was dominated by recruits ranging at 13-22cm and 34-40cm, representing both poor year classes 1991 and 1993 (Fig. 4). In 1994, no mature cod were caught.

During 1982-1986, American plaice fluctuated at high levels of 62-115 million individuals and 8,000-22,000 tons, but continued to decrease since then by 90% and 93%, respectively. In 1994, stock estimates amounted to 11 million individuals and 1,100 tons. Length structures in 1993 and 1994 were dominated by small fish varying from 13-18cm (Fig. 4).

Since 1982, golden redfish (>=17cm) decreased continuously from 130 million and 60,000 tons by 99% to 1.3 million individuals and 500 tons in 1994. During 1993 and 1994, the length structure of this stock was composed mainly by juvenile fish being smaller than 30cm (Fig. 4). Reappearing peaks around 20cm and 25cm migth indicate annual growth increment.

Abundance and biomass estimates for beaked redfish (>=17cm) varied without any distinct trend, but were extremely low during the most recent 3 years (Tab. 4 and 5). High confidence intervals resulting from extreme varation in catch per tow data indicate that the estimates are very inprecise, perhaps because of incomplete survey coverage of stock distribution. In 1994, the length frequency was dominated by small fish around 19cm (Fig. 4).

Juvenile and unspecified redfish (<17cm) dominate the category of other finfish. In 1993 and 1994, the length distributions peaked at 6, 9 and 12 cm (Fig. 4).

The abundance of Atlantic wolffish varied without a clear trend between 9 million and 23 million individuals, whereas the biomass decreased continuously by 91% from 26,000 tons in 1982 to 2,200 tons in 1994, pointing to a pronounced reduction in fish size. The analysis of the length distributions in 1993 and 1994 reveal the dominance of small fish <30cm (Fig. 4).

Spotted wolffish were caught rarely during the whole survey period, but abundance and biomass estimates decreased significantly. Since 1982, these indices are reduced by 76% and 96% to 360,000 individuals and 311 tons in 1994, respectively. Recently, the majority of the fish are very small, displaying pronounced peaks at 16cm and 22-25cm (Fig. 4).

During 1982-92, starry skates varied in abundance and biomass without a clear trend. However, the most recent values in 1993 and 1994 amounted to 4 million and 5 million individuals and 600 tons, respectively. Compared to the mean of the previous 11 years, these estimates reflect a reduction by 49% in abundance and 73% in biomass. Figure 4 reveals the frequent occurrence of individuals <15cm and the dominance of fish <25cm.

Table 6 lists the catch data by species of a standard haul conducted unintentionally side by side with a Greenlandic shrimp trawler in 1994. The by-catch of groundfish amounted to 64kg or 28% as compared to the total catch of 225kg, the shrimp catch being 161kg or 72%. All dominat species contributed to the by-catch, mainly juvenile redfish, American plaice but also golden redfish, Greenland halibut, wolffishes and cod.

Discussion

During 1982-94, survey results indicated fundamental shifts in species *composition* of the demersal fish assemblage inhabiting the shelf and continental slope off West Greenland in Divisions 1B-1F down to 400m depth. These observations happened in coherence with dramatic changes in stock abundance, biomass and size structure for ecologically and economically important species. Recent decreases of biomass estimates for demersal stocks of cod, American plaice, golden redfish, Atlantic and spotted wolffish and starry skates vary between 73% and almost 100%, losses in abundance being less pronounced. Length distributions revealed that these stocks are mainly composed of small and juvenile fish at present. Annual changes in aggregate fish biomass (production) have been related significantly to the occurrence of cod recruits at age 3 and fishing effort directed to groundfish (Rätz, 1994) explaining 87% of the observed variation. Similar stock collapses without any clear indication for biomass compensation have been described for Divisions 2J3KL (Atkinson, 1993).

The status of the demersal fish assemblage stagnates at that low level since 1990 lacking any signs of recovery, although no fishing effort was recently directed towards groundfish. The absence of recovery might be explained by the dominance of juvenile fish and the poor abundance of the stocks, their status being unable to ensure normal recruitment, and the increased effort of the shrimp fishery, having a negative effect on survival rates of recruits due to unreported by-catches. The finfish by-catch of a standard survey haul side by side with a shrimp trawler in 1994 amounting to 28% in weight points to the latter effect, although the different catch procedure of the shrimp fishery (different nets and lower towing speed) prevents direct estimation. In view of their poor status and unreliable catch figures, short term recovery of the demersal stocks must be considered as unlikely and the present situation does not allow to formulate any long term prediction.

References

Atkinson, D. B. 1993. Some Observations on the Biomass and Abundance of Fish Captured During the Stratified Random Bottom Trawl Surveys in NAFO Divisions 2J3KL, Fall 1981-91. NAFO SCR Doc. 93/29, Ser. No. N2209: 1-18

Cochran, W. G. 1953. Sampling techniques. John Wiley & Sons Inc., New York: 1-330

Rätz, H.-J. 1994. Status of the Demersal Fish Assemblage off West Greenland and a Simple Production Model, 1982-93. NAFO SCR Doc. 94/7, Ser. No. N2363:1-15

Saville, A. 1977. Survey methods of apprising fishery resources. FAO Fish. Tech. Pap. 171: 1-76

Table 1 Trawl parameters of the survey.

Gear	140-feet bottom trawl
Horizontal net opening	22 m
Standard trawling speed	4.5 kn
Towing time	30 minutes
Coefficient of catchability	1.0

Table 2 Specification of strata.

Stratum	geographic boundaries				depth	area
	south	north	east	west	(m)	(nm2)
1.1	64°15'N	67°00'N	50°00'W	57°00'W	1-200	6805
1.2	64°15'N	67°00'N	50°00'W	57°00'W	201-400	1881
2.1	62°30'N	64°15'N	50°00'W	55°00'W	1-200	2350
2.2	62°30'N	64°15'N	50°00'W	55°00'W	201-400	1018
3.1	60°45'N	62°30'N	48°00'W	53°00'W	1-200	1938
3.2	60°45'N	62°30'N	48°00'W	53°00'W	201-400	742
4.1	59°00'N	60°45'N	44°00'W	50°00'W	1-200	2568
4.2	59°00'N	60°45'N	44°00'W	50°00'W	201-400	971
Sum						18273

Table 3 Numbers of valid hauls by stratum and total, 1982-94.

Year	1.1	1.2	2.1	2.2	3.1	3.2	4.1	4.2	Sum
1982	20	11	16	7	9	6	13	2	84
1983	26	11	25	11	17	5	18	4	117
1984	25	13	26	8	18	6	21	4	121
1985	10	8	26	10	17	5	21	4	101
1986	27	9	21	9	16	7	18	3	110
1987	25	11	21	4	18	3	21	3	106
1988	34	21	28	5	18	5	18	2	131
1989	26	14	30	9	8	3	25	3	118
1990	19	7	23	8	16	3	21	6	103
1991	19	11	23	7	12	6	14	5	97
1992	6	6	6	5	6	6	7	5	47
1993	9	6	9	6	10	8	7	0	55
1994	16	13	13	8	10	6	7	5	78
Sum	262	141	267	97	175	69	211	46	1268

Table 4 Abundance indices (1,000) of specified fish stocks, others and total off West Greenland, 1982-94. Confidence intervals (CI) are given at the 95% level of significance in per cent of the stratified mean.

YEAR	COD	CI	A.PLAICE	CI	G.REDFISH	CI	B.REDFISH	CI	A.WOLFFISH	CI	SP.WOLFF.	CI	ST.SKATE	CI	OTHERS	TOTAL
1982	92276	28.9	78028	31.8	132357	111.1	3116	105.1	23069	25.1	1508	32.8	9697	39.2	12565	352616
1983	50203	28.8	115443	53.8	28714	35.0	8884	66.3	15427	28.2	873	41.5	6999	87.8	17705	244248
1984	16684	38.1	89604	46.6	24091	38.9	5405	82.4	11023	23.9	787	26.5	6314	44.7	26496	180404
1985	59343	39.2	62397	29.5	45471	44.5	810	115.3	12741	33.4	628	51.4	7878	45.7	50065	239333
1986	145680	35.0	111513	44.6	43314	43.2	3333	76.3	12090	31.3	1033	30.6	6706	48.1	277199	600868
1987	786392	62.6	56248	33.5	13157	57.1	14765	78.9	9568	26.9	946	41.9	3337	32.6	417074	1301487
1988	626494	49.7	33562	25.0	14290	40.4	8819	79.0	10497	30.8	935	35.2	7148	39.7	182560	884305
1989	358726	73.4	39172	34.0	9160	61.9	303	59.1	10560	32.8	843	42.4	19419	38.8	53078	491261
1990	34524	71.0	29102	36.3	4996	34.4	4649	112.1	10414	26.7	622	35.1	13325	53.6	125465	223097
1991	4805	52.4	23785	25.1	3724	61.0	2425	106.4	9863	30.6	721	34.3	4832	27.1	225294	275449
1992	2042	60.7	24106	29.4	2193	43.1	157	94.2	13164	28.6	313	55.4	10710	50.9	142071	194756
1993	1437	31.9	13277	19.7	1188	53.1	190	159.6	8849	47.3	530	43.5	4126	42.6	120464	150061
1994	574	35.6	11494	23.9	1266	41.8	678	54.3	11971	66.7	358	36.0	4775	48.0	95558	126674

Table 5 Biomass indices (tons) of specified fish stocks, others and total off West Greenland, 1982-94. Confidence intervals (CI) are given at the 95% level of significance in per cent of the stratified mean.

YEAR	COD	CI	A.PLAICE	CI	G.REDFISH	CI	B.REDFISH	CI	A.WOLFFISH	CI	SP.WOLFF.	CI	ST.SKATE	CI	OTHERS	TOTAL
1982	128490	26.4	17394	33.7	55682	100.2	1109	116.4	26002	32.9	7950	46.5	6091	37.1	23428	266146
1983	82375	31.9	22246	47.3	14178	37.3	4270	77.4	12788	35.7	5693	45.3	2413	33.7	16366	160329
1984	25565	39.3	13294	51.0	11225	46.9	1771	88.7	6998	25.8	3956	32.6	1920	37.0	7256	71985
1985	35672	72.9	8354	30.1	19634	58.4	260	108.3	5959	25.5	1822	43.8	2166	24.2	12894	86761
1986	86717	35.1	14726	40.6	18068	46.4	574	64.6	6767	25.3	3501	38.3	1774	31.8	14997	147124
1987	638589	68.8	9809	39.9	6553	62.6	1307	62.4	4950	25.8	4178	41.3	1067	33.8	19759	686212
1988	607988	50.1	4905	29.0	5902	41.1	2549	92.4	4504	21.2	4755	59.4	1744	29.9	20429	652776
1989	333850	65.9	5071	54.7	3669	63.5	46	49.8	4563	25.3	2841	49.9	3996	31.9	5717	359753
1990	34432	70.0	3044	35.2	2438	46.2	643	109.4	3130	23.0	2255	49.0	2229	48.4	4717	52888
1991	5150	76.3	2246	27.9	1778	74.3	598	103.7	2229	30.8	1227	69.2	908	31.2	4633	18769
1992	607	64.4	1991	28.1	947	48.9	33	105.4	2969	23.0	126	87.0	1054	30.8	3428	11155
1993	359	37.6	894	20.6	384	47.2	29	129.8	1448	36.5	415	83.7	601	33.8	2425	6555
1994	139	36.1	1073	32.9	473	42.6	84	51.2	2242	63.6	311	99.9	643	27.2	3228	8193

Table 6 Catch of a standard haul conducted unintentionally side by side with a Greenlandic shrimp trawler in 1994.

Date: 07.11.94, 11.40h Position: 65°42.9'N 055°29.6'W Depth: 331-357m

Species	Weight (kg)	Number
Gadus morhua	0.42	2
Sebastes marinus	6.89	14
Sebastes spp. juv.	13.54	838
Anarhichas lupus	3.85	9
Anarhichas minor	1.6	5
Eumicrotremus spinosus	0.32	9
Careproctus reinhardti	0.12	2
Artediellus atlanticus	0.04	3
Artediellus uncinatus	0.03	1
Cottunculus microps	0.39	9
Triglops murrayi	0.06	2
Leptagonus decagonus	0.05	2
Reinhardtius hippoglossoides	4.35	40
Hippoglossoides platessoides	29.47	118
Raja radiata	2.82	15
Sum finfish	63.95	1069
Pandalus borealis	160.76	
Sum total	224.71	

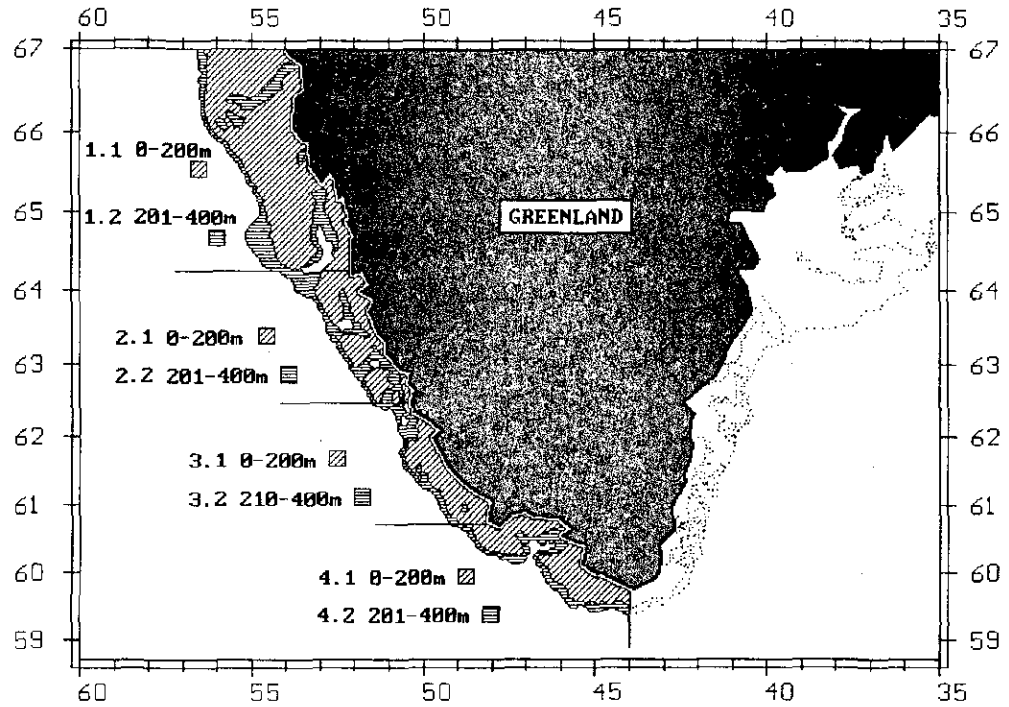

Fig. 1 Survey area and straticication scheme as specified in Table 2.

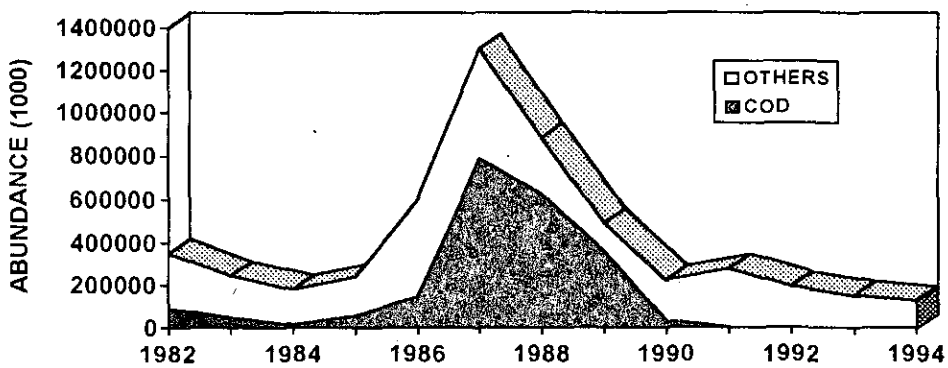

Fig. 2 Aggregate fish abundance indices for cod and others as listed in Table 4, 1982-94

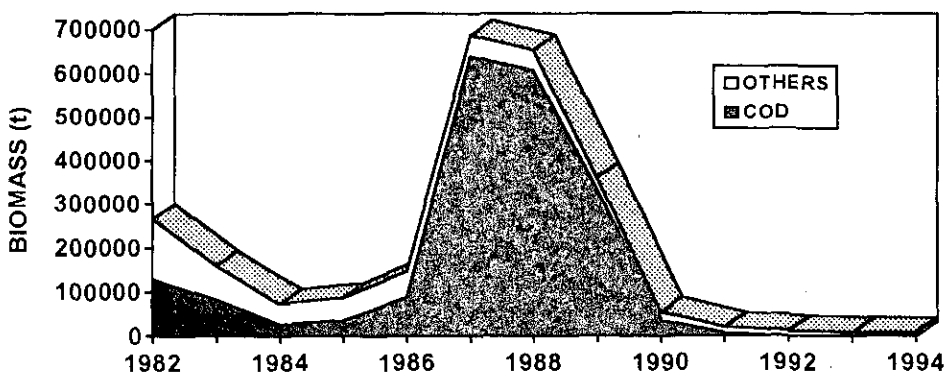

Fig. 3 Aggregate fish biomass indices for cod and others as listed in Table 5, 1982-94.

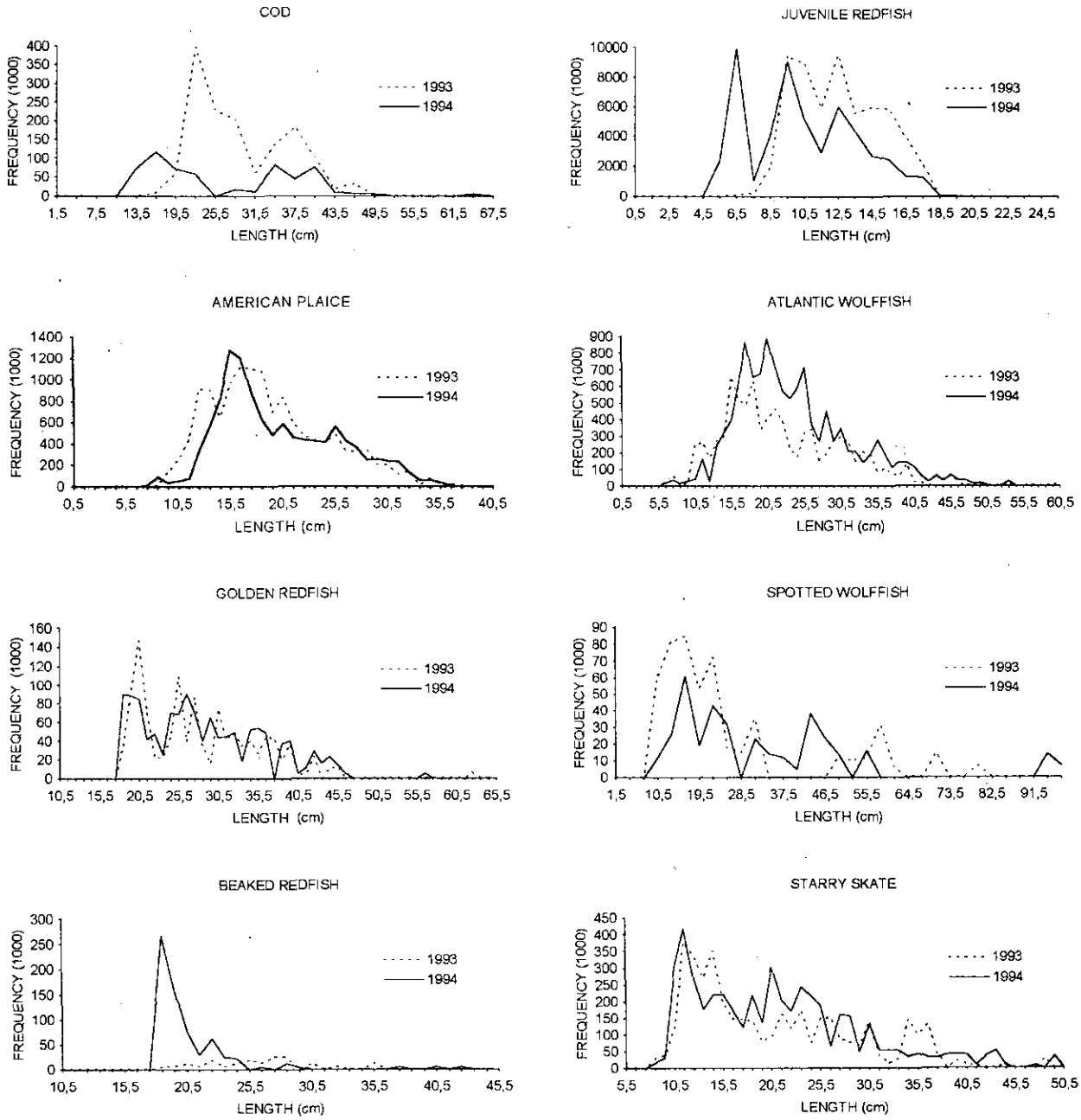

Fig. 4 Length structure of specified fish stocks in 1993 and 1994.