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Biomass and Abundance of Demersal Fish Stocks off West Greenland Estimated from the Greenland Shrimp Survey, 1988-2004.

by

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Abstract

Since 1988 Greenland Institute of Natural Resources has annually conducted a bottom trawl survey off West Greenland. The main purpose of the survey is to evaluate the biomass and abundance of Northern shrimp (*Pandalus borealis*), but data on fish spices have been recorded since 1992. This paper presents biomass and abundance estimates together with length frequencies of cod, Greenland halibut, redfish, wolffishes, American plaice and starry skate from the 1992-2004 surveys. Further, a recruitment index for Greenland halibut is presented.

Materials and Methods

The survey covers the offshore areas at West Greenland between 59°15'N and 72°30'N from the 3-mile limit to the 600 m depth contour line and the inshore area Disko Bay and Julianehåbs Bay (Fig. 1 and Table 1). The survey area is divided into NAFO Divisions, which were further subdivided into five depth strata (50-100, 101-150, 151-200, 201-400 and 401-600) on basis of depth contour lines. The area surveyed has, however, changed throughout the years. From 1988 to 1990 the survey area included Div. 1AN to 1D. In 1991 the Div. 1AN was not covered. In 1992 the survey area was extended to include Div. 1AN to 1F and Disko Bay (Div. 1AX), and this area is now surveyed annually. The survey was originally designed as a shrimp survey and sampling of fish data was not complete in the period 1988-1991. Since 1992 the sampling of fish has improved and the survey is now considered as a combined groundfish/shrimp survey. The survey period is July to September.

The survey is designed as a stratified-random trawl survey. A minimum of two hauls per stratum is always planned. Due to new information on the bottom topography in Div. 1AN and Disko Bay a re-stratification has been conducted and the historic data has been recalculated according to the new information. Numbers of stations have been fluctuating between 179 and 245 per year, and the total number of valid hauls in 2004 was 209. The number of valid hauls by year and stratum is listed in Table 2.

The surveys have been conducted with trawlers of the same size throughout the years. Since 1991 the 722 GRT stern trawler M/Tr 'Pâmiut' has been used. The trawl is a Skjervoy 3000/20 with bobbin gear and double bag. The mesh size in the codend was 40mm from 1988 to 1992. From 1993 the mesh size in the codend has been 20 mm. The changes of mesh size did not influence the catchability of fish except for redfish. Abundance estimates for redfish before 1993 are therefore adjusted in according to Bech, 1994. The trawl doors in use are of the type 'Perfect', except

for the 1989 survey where 'BMV' doors were used. Wing spread is set as 19.0 m. The standard trawling time offshore is 15-30 minutes at a mean towing speed of 2.5 knots. The trawling operations are performed during day time only. After each haul the catch was sorted by species or lowest taxonomic level and weighed to 0.1 kg and the number recorded. Fish was measured as total length to 1 cm below. The caches of redfish consisted almost exclusively of specimens <20 cm. Due to difficulties in identification of species all redfish were classified as *Sebastes sp.*

Stratified abundance and biomass estimates were calculated from catch-per-tow data using the stratum areas as weighting factor (Cochran, 1977). The coefficient of catchability was set at 1.0, implying that estimates are merely indices of abundance and biomass. Confidence intervals (CI) were set at the 95% level of significance of the stratified mean. In recent years the principles for the allocation of trawl hauls in the survey has been changed in order to reduce the variance in the estimate of abundance and biomass of shrimp. In order to reduce the effect of this, the estimation of CPUE (recruitment of year one Greenland halibut), has been recalculated including only hauls>300 m in the calculations.

Catch per unit effort (CPUE) for Greenland halibut was calculated in numbers per year-class per hour. Separation of ages was based on the Petersen method.

The available age and maturity data on American place, Atlantic and spotted wolfish and starry skate were considered to be insufficient for a reliable calculation of spawning biomasses as recommended by STACFIS in 2001.

Results

Greenland halibut (*Reinhardtius hippoglossoides*)

Greenland halibut was found in all divisions, but was most common in Div. 1AN-1BN and in the Disko Bay. In 2004 the abundance and biomass was estimated to 470 million individuals and nearly 60 000 tons (Tables 3 and 4). The increase in biomass was especially pronounced in division 1AX (Disko Bay), however an increase were also observed in division 1BN and 1AN. The abundance and biomass has fluctuated in the period 1992-2000 between 260-420 mill individuals and 13 000-31 000 tons (except in 1996). In 1996 the abundance increased to 512 mill. individuals, witch is the largest figure in that period. Since 2000 the abundance and especially the biomass has increased with a record high abundance in 2003 and biomass in 2004, indicating twice as high biomass in 2004 compared to last year. Distribution of survey catches in number pr. hour and kg pr. hour are shown in Fig. 1 and Fig. 2 for 2004.

The length distribution ranged between 6 and 67 cm with the main caches below 35 cm and two clear modes around 13 cm and 25 cm, larger fish has been caught in 2004 compared to previous years (Fig. 3).

The CPUE (number per hour of age 1 (2003 year-class)) was estimated at 359.0 specimens in the offshore nursery area (Div. 1AS, 1BN and 1BS), which is somewhat below average for the time series (552.7) (Fig 4a). Generally there is a steep decline between CPUE at age 1 and age 2 and 3+. The CPUE of age 3+ (year-class 2001 and older) (65.2 specimens per hour) was however the highest seen since the 1992 year-class. In the Disko Bay the CPUE was estimated at 1 432.7 specimens of age 1 per hour, which is a drop compared to the 2002 year-class but still well above average for the time series. The 2002 year-class and especially year-class 2001+ were still strong in the 2004 survey in Disko Bay (Fig. 4b).

Redfish (*Sebastes sp.*)

Redfish was found in all the survey areas, but was most common in Div. 1BN and 1F. In 2004 the abundance and biomass was estimated to 253 million individuals and 11 500 tons. Distribution of survey catches in kg pr. hour and number pr. hour are shown in Fig. 5 and Fig. 6.

Tables 5 and 6 list abundance and biomass indices by stratum. The abundance and biomass estimated in the period 1992-1996 have fluctuated without a clear trend between 0.9-2.4 billion individuals and 14 000-38 000 tons. From 1997-2004 biomass and abundance have decreased to between 165-719 millions individuals and 11 000-23 000 tons.

A historic low was observed in abundance in 2000 but after an in increase last year in biomass as well as abundance, the level decreased again in 2004 to a historic low biomass (Table 5 and 6).

During the years catches has comprised almost exclusively of specimens less than 20 cm. Annual growth increments of 4 cm were indicated by repeatedly pronounced peaks in length compositions at 7-8 cm and 12 cm probably corresponding to age 1 and 2 (Nederaas, 1990). Figure 7 shows the abundance estimate as a function of the length distribution. There is a low consistency in year-class strength indicating a high mortality. The resent four survey estimates revealed only small peaks at 7-8 cm and 10-14 cm, leaving no sign of prominent future recruitment. In 2004 two week modes at 7-8 cm and 12-13 cm were seen.

American plaice (*Hippoglossoides platessoides*)

American plaice is mainly found in Div. 1B-1D. In 2004 the biomass and abundance was estimated to 43 million individuals and 2 800 tons, which is a decrease compared to large years historic high, although the second largest value in the time series (Tables 7 and 8). The abundance and biomass estimates for American plaice has varied between 10 and 72 millions individuals and 700 and 4 000 tons, with an increase the latest years. In 2004 the length ranged between 5 and 35 cm (Fig. 8). A mode at 8-11 and somewhat weaker modes at 12-19, 25-27 and 30-32 cm is found in 2003 as well as in previous years.

Atlantic wolffish (*Anarhichas lupus)*

Atlantic wolffish has in the past mainly been caught south of 68°00'N but in the latest years this picture has changed and in 2003 and 2004 large abundance were found in 1BN (Table 9 and 10). In 2004 the abundance and biomass was estimated to 4.1 million individuals and 600 tons. 2003 was the highest estimate in the time series, and the 2004 values are only estimated to half of the 2003 biomass although still third largest. The abundance and biomass has from 1992-2001 varied through the time series without any significant trend with highest estimates in 1994 (4.8 million individuals and 644 tons) and lowest in 1992 (0.8 million individuals and 163 tons).

In 2004 the length ranged between 5 and 55 cm (Fig. 9). The analysis of the length distribution reveals the dominance of small fish <35cm. In earlier years a peak at 8-12 cm 1has been observed but not in 2004. However a rather large peak was observed at 22 cm, which is considered rather unusually indicating that in this years' survey larger fish was caught.

Spotted wolffish (*Anarhichas minor*)

Spotted wolffish is distributed in all survey areas, in 2004 mainly in Div. 1AN and 1BN. In 2004 the biomass and abundance was estimated to 2 million individuals and 4100 tons (Tables 11 and 12), the biomass is the highest estimate in the time series. The abundance and biomass has varied through the time series but has been increasing since the survey start.

Only in the last three years enough spotted wolffish were caught in the survey to reveal meaningful length distributions. In 2004 the length ranged from 10-75 cm. In 2003 a large clear mode was evident at 10-15 cm but was not retrievable in 2004. Two small peaks were found at 17 and 25 cm. (Fig. 10).

Cod (*Gadus morhua*)

Cod was captured from Disko Bay and south in the 2004 survey. Since 1999 larger part of the catches have been caught in 1AX and 1BN. Tables 13 and 14 list abundance and biomass indices of cod by stratum. In years 1991-2000 the biomass-indices for cod were estimated between 50-600 tons. Since 2001 the biomass has however increased and was in 2004 estimated to be 2 400 tons and 6.5 millions individuals which is the highest estimate in time series.

Figure 11 gives the length distribution of cod in the survey during the years. Especially the age group one ranging between 15 and 20 cm was very evident and distinct modes at 30 cm – the largest age group one in the time series, 26-32 and 42cm was also recognisable in the 2004 survey.

Starry skate *(Raja radiata*)

The biomass is distributed in all survey areas, but in 2004 the main catches were in the northern parts. The abundance and biomass of starry skate have during the years been fluctuating without any significant trend between 6-17 million individuals and 900-4 500 tons, with a historic high in 2003. In 2004 abundance was estimated to 7.8 million individuals and 2 700 tons (Table 15 and 16). No length data are available for this species.

Discussion

The survey was originally designed as a shrimp survey. The fish data are incomplete and the survey did not cover the same area in the period 1988-1991. Direct comparison was hence only possible for the period 1992-2003. The main purpose of the survey is to evaluate the biomass of northern shrimp and most effort is concentrated in the areas and depths where the commercial shrimp trawling is taking place, especially on the northern slopes of the grand bank Store Hellefiskebanke (67°50N 55°00W) and in the inshore area Disko Bay. As Store Hellefiskebanke and Disko Bay are important nursery areas for Greenland halibut and redfish as well as other important species (Smidt, 1969; Tåning, 1949) it is likely, that the abundance and biomasses estimates of the survey reflects the juvenile stock situation of these species, however the relatively short time series and the high variability on estimates calls for some reservations. The abundance level of redfish has been low since 1996 although some recovery potential was observed in 2003 both abundance and biomass indices dropped again in 2004. There seems to be a continued recruitment of Greenland halibut both in the Disko Bay area and the off shore area. The survey shows, however, a drastic decline in abundance between age one and age two for both Greenland halibut and redfish. This could be caused by high mortality, migration out of the survey area, or a change in chatchability by age. One year old Greenland halibut is known to be much more pelagic compared to older age classes (Jørgensen, 1997), and is hence caught more easily by a 15 m high shrimp trawl, than older age classes, while older age classes probably are able to escape under the trawl, that is attached to the ground gear with 75 cm long straps. The 2001 year-class was, as age three, however, relatively strong in the Disko Bay. Whether this is caused by a change in catchability, immigration from the offshore areas or an effect of the introduction of separator grids in 2000, or temperature effect is unknown.

According to a number of investigations the fishable part of all ground fish stocks off West Greenland has been severely depleted during the last decade (Rätz, 1998a; Rätz, 1998b; Ogawa *et al*. 1994; Yokawa *et al*., 1995). The low biomass and abundance of cod, American plaice, wolffish and starry skate presented in this paper supports this general picture. The latest years some recovery potential has been recorded in the fish stocks but most indices dropped again in 2004. A large part of the increase observed in previous yeas was in most of the species seen in the Northern divisions. An explanation for this increase could be; 1) An increase in the water temperature has been observed the latest 6-7 years reaching a historic high in 2003 (Stein, 2004). 2) An extensive shrimp fishing on traditional fishing grounds is suspected to have had a negative effect on the survival rates of recruits during the years. In order to reduce the by-catch in the shrimp fishery Greenland introduced the 1. October 2000 mandatory use of sorting grids with bars spaced 22 mm into the full geographic range of the Greenland shrimp fishery. Results of experimental fishing with 22 mm sorting grids shows a nearly complete protection to finfish larger than about 20 cm, but poor protection of the smallest fish (Engelstoft *et al*., 2000). Besides the introducing of sorting grids Greenland shrimp trawling regulations require ships to change grounds by at least 5 miles as soon as by-catch exceeds limits. 3) The increase could also bee an effect of both a raise in temperature and sorting grids. 4) The increase in cod abundance could be caused by an incoming Icelandic year-class contributing to the small offshore cod stock in Greenland water.

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Table 1. Specification of strata. 1AX=Disko Bay.

Stratum					depth	area
	south	north	east	west	(m)	(km2)
1AN	70º37.5'N	72º30 'N	54º15'W	60º30'W	50-99	325.8
-					100-149	601.4
-					150-199	1951.9
-					200-399	19228.8
-					400-599	9255.6
1AS	68º50 'N	70º37.5'N	54º15'W	60º30'W	50-99	1793.7
-					100-149	3431.6
-					150-199	7187.5
-					200-399	16165.6
-					400-599	6177.5
1AX	68º50'N	70º37.5'N	51º00'W	54º15'W	50-99	603.5
-					100-149	1177.9
-					150-199	1185.4
-					200-399	6671.4
-					400-599	3436.7
1BN	67º00 'N	68º50 'N	50º00'W	59º45'W	50-99	5602
-					100-149	3333.2
-					150-199	2815.5
-					200-399	16935.6
-					400-599	3523.7
1BS	66º15 'N	67º00 'N	54º00'W	57º00'W	50-99	2034.7
-					100-149	1543.6
-					150-199	2879.8
-					200-399	1424
-					400-599	1257.3
1C	64º15 'N	66º15 'N	52º30'W	57º00'W	50-99	4196.1
-					100-149	8035.1
-					150-199	3592.7
-					200-399	4735.2
-					400-599	3452.9
1D	62º30 'N	64º15 'N	50º30'W	54º00'W	50-99	3137.3
-					100-149	1810.5
-					150-199	1062.2
-					200-399	3463.1
-					400-599	1081.9
1E	60º45 'N	62º30 'N	48º30'W	52º00'W	50-99	719
-					100-149	2435.5
-					150-199	2258.6
-					200-399	2187.6
-					400-599	647.6
1F	59º15'N	60º45 'N	44º30'W	49º15'W	50-99	1244.6
-					100-149	4747.8
-					150-199	2605
-					200-399	2719.7
-					400-599	1312.5
Total West Greenland					50-600	1517306.7

Table 2. Numbers of valid hauls, 1988-2004. 1AX=Disko Bay.

Year	1AN	1AS	1AX	1BN	1BS	1C	1D	1E	1F	Westgr.-1AX	Total
1990	29	63	*	68	17	35	16	*	*		228
1991	18	39	41	44	18	11	16	*	*	146	187
1992	20	33	39	36	8	18	18	11	15	159	198
1993	16	22	31	39	10	21	15	12	13	148	179
1994	16	33	27	49	9	23	8	9	9	156	183
1995	17	33	33	48	13	29	13	14	11	178	211
1996	18	20	33	46	11	29	12	9	11	156	189
1997	17	33	34	47	9	32	12	12	19	181	215
1998	10	34	33	66	14	27	19	14	14	198	231
1999	10	40	34	63	18	33	16	14	17	211	245
2000	8	25	23	45	17	37	23	14	29	198	221
2001	9	28	23	59	16	36	24	15	26	213	236
2002	2	26	22	68	12	32	18	20	27	205	227
2003	11	21	19	51	12	30	18	15	22	180	199
2004	15	25	14	41	14	24	22	20	34	195	209

Table 3. Greenland halibut (*Reinhardtius hippoglossoides*). Abundance indices ('1000) for West Greenland with 95% confidence limits in percent of the stratified mean. () incomplete coverage of survey area.

Year	1AN	1AS	1AX	1BN	1BS	1C	1D	1E	1F	Westgr-1AX	Westgr.	CI
1990	7039	2072	*	6661	193	3844	353	*	*		(16530)	23
1991	13630	6692	34030	152800	3890	939	3415	*	*	(181370)	(215400)	25
1992	50700	8183	96730	231500	1499	1183	800	614	0	294470	391200	27
1993	29120	24250	33960	152600	9799	4275	4563	447	497	229540	263500	28
1994	22900	35220	62960	130700	9970	18070	2350	142	439	219840	282800	22
1995	39460	28910	89410	98870	18340	12190	5720	146	343	203990	293400	32
1996	92560	13710	102500	265900	11760	14040	10710	155	363	409200	511700	25
1997	41260	17450	112100	97630	2244	13040	865	108	258	172900	285000	22
1998	78460	30350	209600	47190	23320	7168	3563	1382	578	192000	401600	29
1999	100800	58160	95360	91040	5805	5290	7708	1299	912	270940	366300	35
2000	81660	19310	172800	126700	4065	4792	6715	139	565	244000	416800	30
2001	145900	97870	223700	111500	1679	4808	2553	669	1597	366500	590200	28
2002	77960	75220	148100	42490	2699	6157	6482	552	1268	212800	360900	38
2003	154600	37690	227000	116700	2312	1964	2441	69	993	316800	543800	36
2004	154800	20640	199100	84760	2423	2917	2849	88	351	268900	468000	34

Table 4. Greenland halibut (*Reinhardtius hippoglossoides*). Biomass indices (tons) for West Greenland with 95% confidence limits in percent of the stratified mean. () incomplete coverage of survey area.

Year	1AN	1AS	1AX	1BN	1BS	1C	1D	1E	1F	Westgr-1AX	Westgr.	CI
1990	1844	697	*	3602	3	305	126	*	*		(6578)	23
1991	1213	612	2510	2842	280	194	238	*	*	5379	(7889)	26
1992	3516	785	4992	4203	402	206	97	48	0	9258	14250	22
1993	2483	1286	2507	4255	747	595	539	333	60	10297	12804	27
1994	2007	1697	3598	4748	1665	1458	91	10	25	11601	15199	26
1995	4367	1291	5786	2567	825	971	502	12	45	10579	16365	51
1996	3682	1294	8593	5496	439	1248	899	9	118	13185	21778	22
1997	4972	1746	6456	4929	421	1754	180	25	84	14111	20567	29
1998	7025	4976	11874	2821	1724	863	275	117	278	18081	29955	35
1999	10205	6025	8060	5224	555	778	261	48	318	23413	31473	44
2000	3411	1713	9537	3985	454	692	567	38	280	11138	20676	30
2001	8433	2478	10161	3802	278	1208	289	33	443	16965	27126	32
2002	6158	2067	9070	3108	779	737	670	39	402	13985	23055	40
2003	8297	3399	16556	5693	478	589	297	4	355	19112	35668	28
2004	15182	2079	28229	11755	1147	420	319	2	201	31103	59332	36

Table 5. Redfish (*Sebastes sp.*). Abundance indices (‘1000) for West Greenland with 95% confidence limits in percent of the stratified mean.

Year	1AN	1AS	1AX	1BN	1BS	1C	1D	1E	1F	Westgr.	CI
1992	751	145500	9118	1006000	187300	69150	34430	6308	4165	1462000	32
1993	3704	210200	17270	360500	21480	156800	182000	96790	519600	1568000	69
1994	12270	187100	11510	1573000	224700	273000	85430	9477	84390	2461000	26
1995	843	67040	11140	559000	33370	182700	93020	4563	4960	956600	23
1996	998	7725	8186	1688000	59270	123900	62840	11370	53980	2016500	29
1997	5257	43260	6715	348000	58220	156300	56610	22930	21920	719300	24
1998	492	23670	19830	235800	14580	115000	70680	9908	31700	521600	24
1999	2302	69440	9249	287000	11180	10700	60880	4172	22710	573900	21
2000	0	27120	6044	26520	31570	27600	10120	17880	159256	165300	23
2001	2295	76470	2586	24970	15380	20380	12020	1179	180314	182900	60
2002	645	23050	1118	50390	83760	42470	44440	1677	9661	257200	27
2003	2142	44840	1625	210300	32320	78980	25340	1887	25560	423000	23
2004	2353	10820	824	52040	38800	46740	30190	1806	68990	252600	37

Table 6. Redfish (*Sebastes sp.*). Biomass indices (tons) for West Greenland with 95% confidence limits in percent of the stratified mean. () incomplete coverage of survey area.

Year	1AN	1AS	1AX	1BN	1BS	1C	1D	1E	1F	Westgr-1AX	Westgr.	CI
1990	90	2789	*	6951	28	1890	725	*	*		(12473)	20
1991	117	447	373	13781	1072	1175	2222	*	*	18814	(19187)	24
1992	69	18117	437	13423	2832	1576	1124	169	147	37457	37894	43
1993	195	4994	710	6420	300	1549	3835	1923	2138	21355	22065	38
1994	590	5076	538	16064	1986	3886	995	179	1272	30048	30586	24
1995	52	1585	775	5029	869	2963	1952	358	123	12930	13705	22
1996	18	117	782	12178	1694	2552	1980	304	1788	20631	21413	28
1997	599	1481	337	4913	1597	6766	1901	1099	1229	19585	19922	31
1998	39	1467	1423	6193	2130	3274	1953	606	1198	16860	18283	22
1999	164	4021	742	5596	999	2742	2976	207	1124	17929	18671	25
2000	0	1790	793	1045	2185	2337	463	2411	1214	11444	12237	36
2001	192	5380	536	1746	1460	2637	1069	60	2256	14801	15337	50
2002	55	1917	397	2536	2386	1676	2654	272	998	12494	12891	28
2003	279	2886	702	6357	2319	6185	1918	187	2476	22606	23308	32
2004	369	462	368	2210	2274	2996	1679	101	1026	11118	11486	41

Table 7. American plaice (*Hipplogossoides platessoides*). Abundance indices (‘1000) for West Greenland with 95% confidence limits in percent of the stratified mean. () incomplete coverage of survey area.

Year	1AN	1AS	1AX	1BN	1BS	1C	1D	1E	1F	Westgr-1AX	Westgr.	CI
1991	52	803	1759	1777	561	2509	2688	*	*	11078	(12837)	31
1992	1399	958	2762	1441	604	1666	1372	525	59	8028	10790	22
1993	1273	1718	1200	2969	780	1989	1739	624	938	12030	13230	24
1994	2219	3665	3338	14940	6952	9501	703	258	485	38682	42020	32
1995	962	551	1833	6340	945	2681	2988	332	532	15327	17160	29
1996	1631	3390	7318	4593	1676	4198	3055	114	670	19322	26640	18
1997	6576	1961	2662	15130	1046	10370	2017	335	699	38128	40790	47
1998	1648	1912	2378	3551	1177	1541	6402	921	5640	22792	25170	27
1999	493	1659	2010	6809	1165	5319	1933	990	557	18930	20940	18
2000	1829	4838	6737	14750	1892	3519	3820	529	543	31713	38450	23
2001	1295	1253	2191	13640	1493	3457	2261	592	582	24579	26770	31
2002	0	3823	4734	8807	1777	5097	31840	1537	1849	54726	59460	49
2003	2167	5239	5544	25650	1564	13690	15030	799	1970	66106	71650	22
2004	719	1423	5302	11890	2801	10210	8869	584	1621	38108	43410	27

Table 8. American plaice (*Hipplogossoides platessoides*). Biomass indices (tons) for West Greenland with 95% confidence limits in percent of the stratified mean. () incomplete coverage of survey area.

Year	1AN	1AS	1AX	1BN	1BS	1C	1D	1E	1F	Westgr-1AX	Westgr.	CI
1990	0	2	*	15	7	60	142	*	*		(226)	38
1991	3	23	143	72	61	117	311	*	*	587	(730)	28
1992	57	54	213	78	51	137	128	55	6	566	779	23
1993	56	72	87	90	28	107	141	69	43	607	694	26
1994	112	293	277	487	308	284	60	22	64	1629	1906	22
1995	65	54	279	191	51	87	130	19	18	616	895	18
1996	119	264	670	231	74	142	119	7	27	984	1654	18
1997	323	150	287	398	87	367	135	31	25	1516	1803	21
1998	154	178	328	185	48	82	398	97	102	1245	1573	20
1999	81	136	170	287	43	202	145	65	44	1003	1173	17
2000	175	278	408	551	74	178	227	89	40	1613	2021	18
2001	169	79	140	403	65	162	153	38	67	1136	1276	17
2002	0	184	327	414	151	275	1061	92	67	2243	2570	23
2003	196	352	338	1013	125	680	1048	59	171	3642	3980	20
2004	138	143	192	537	128	715	747	38	150	2597	2789	27

Table 9. Atlantic wolffish (*Anarhichas lupus*). Abundance indices (‘1000) for West Greenland with 95% confidence limits in percent of the stratified mean.

Year	1AN	1AS	1AX	1BN	1BS	1C	1D	1E	1F	Westgr-1AX	Westgr.	CI
1992	0	37	0	30	104	263	99	131	138	803	803	33
1993	0	28	49	26	27	239	189	344	324	1177	1226	41
1994	0	63	20	332	179	1940	366	361	1628	4869	4889	36
1995	0	7	0	86	129	351	87	412	231	1304	1304	34
1996	0	62	5	87	63	424	224	568	610	2038	2043	50
1997	0	30	0	169	30	807	239	280	119	1673	1673	28
1998	0	251	6	346	93	717	371	467	726	2970	2976	30
1999	0	150	110	132	145	407	190	418	415	1857	1967	44
2000	0	542	87	327	414	369	558	1729	47	3886	3973	69
2001	0	137	162	358	55	156	365	228	67	1365	1527	40
2002	0	375	96	496	12	945	588	1057	537	4010	4106	33
2003	0	135	591	2339	190	1545	538	2329	1108	8184	8775	27
2004	0	86	262	1556	941	236	274	703	305	4101	4363	39

Table 10. Atlantic wolffish (*Anarhichas lupus*). Biomass indices (tons) for West Greenland with 95% confidence limits in percent of the stratified mean.

Year	1AN	1AS	1AX	1BN	1BS	1C	1D	1E	1F	Westgr-1AX	Westgr.	CI
1992	0	7	0	8	21	47	22	28	31	163	163	33
1993	0	5	6	1	2	26	35	29	188	286	292	64
1994	0	12	9	40	39	198	30	65	249	635	644	38
1995	0	0	0	22	9	38	24	90	36	219	219	40
1996	0	1	3	17	23	41	35	103	101	321	324	53
1997	0	3	0	21	1	115	16	58	15	228	228	30
1998	0	3	2	13	9	60	34	104	133	356	358	38
1999	0	4	13	21	12	8	6	202	62	316	329	79
2000	0	20	3	52	31	55	54	396	15	623	626	90
2001	0	1	3	11	1	16	21	42	23	114	117	40
2002	0	9	2	77	5	73	78	216	118	577	579	37
2003	0	2	41	267	64	361	60	205	148	1107	1148	24
2004	0	6	19	160	56	96	21	162	100	601	620	27

Table 11. Spotted wolffish (*Anarhichas minor*). Abundance indices (‘1000) for West Greenland with 95% confidence limits in percent of the stratified mean

Year	1AN	1AS	1AX	1BN	1BS	1C	1D	1E	1F	Westgr-1AX	Westgr.	CI
1992	14	74	9	72	11	26	39	18	5	334	268	28
1993	0	131	29	50	34	50	22	0	57	343	372	36
1994	43	304	0	220	84	387	21	12	42	1113	1113	33
1995	0	155	7	57	41	37	48	26	30	395	402	22
1996	131	109	11	120	31	30	30	0	38	489	500	24
1997	94	337	29	247	0	33	58	0	8	778	807	23
1998	75	218	0	182	23	21	38	25	4	586	586	25
1999	856	313	96	396	60	18	5	0	0	1649	1745	42
2000	0	794	30	507	140	27	6	93	0	1568	1598	28
2001	302	356	68	269	40	41	0	0	5	1013	1081	27
2002	258	2147	54	362	108	73	75	10	42	1573	1196	42
2003	505	1515	205	1372	39	601	35	0	55	4123	4328	24
2004	151	743	233	605	3	132	92	39	86	1621	2084	30

Table 12. Spotted wolffish (*Anarhichas minor*). Biomass indices (tons) for West Greenland with 95% confidence limits in percent of the stratified mean.

Year	1AN	1AS	1AX	1BN	1BS	1C	1D	1E	1F	Westgr-1AX	Westgr.	CI
1992	4	76	65	110	3	34	33	6	19	286	351	28
1993	55	0	100	47	16	66	4	0	282	471	571	53
1994	223	180	0	81	40	119	28	11	1	683	683	25
1995	0	60	15	68	16	22	19	11	164	362	377	49
1996	169	77	12	193	15	6	31	0	50	542	554	26
1997	193	72	37	81	0	16	124	0	5	493	530	34
1998	2	64	0	143	18	6	125	100	7	465	465	32
1999	131	121	23	28	36	13	2	0	0	331	354	31
2000	0	188	31	133	36	19	1	593	0	969	1000	114
2001	523	30	25	310	80	4	0	0	10	957	982	52
2002	135	194	20	169	81	74	233	71	126	1084	1104	28
2003	299	1416	195	978	22	741	107	0	226	3790	3985	22
2004	124	1270	623	567	2	78	603	352	545	3541	4164	35

Table 13. Cod (*Gadus morhua*). Abundance indices (‘1000) for West Greenland with 95% confidence limits in percent of the stratified mean. () incomplete coverage of survey area.

Year	1AN	1AS	1AX	1BN	1BS	1C	1D	1E	1F	Westgr-1AX	Westgr.	CI
1991	0	0	10	6	10	337	481	*	*	546	(846)	51
1992	0	0	4	16	37	243	345	0	8	648	653	49
1993	0	0	2	0	16	54	135	286	18	510	512	68
1994	0	10	0	0	41	87	0	6	0	144	144	47
1995	0	0	0	40	11	380	44	62	39	578	578	55
1996	0	0	0	0	0	46	68	87	107	308	308	55
1997	0	0	0	0	7	31	0	0	0	38	38	68
1998	0	0	0	4	0	0	26	26	3	59	59	54
1999	0	12	20	90	46	16	23	6	0	193	213	29
2000	0	186	399	270	167	71	58	9	189	950	1349	23
2001	0	0	26	236	69	110	448	305	313	1482	1508	26
2002	0	0	13	69	134	78	3294	114	457	4145	4158	50
2003	0	112	380	1356	39	351	727	214	211	3011	3391	22
2004	0	0	197	37	115	379	2630	1538	1610	6310	6507	29

Table 14. Cod (*Gadus morhua*). Biomass indices (tons) for West Greenland with 95% confidence limits in percent of the stratified mean. () incomplete coverage of survey area.

Year	1AN	1AS	1AX	1BN	1BS	1C	1D	1E	1F	Westgr-1AX	Westgr.	CI
1990	2	13	*	75	3	83	9005	*	*		(9180)	65
1991	0	0	7	2	15	151	310	*	*	478	(485)	44
1992	0	0	3	20	34	75	118	0	2	248	251	45
1993	0	0	2	0	5	25	39	124	5	198	200	70
1994	0	3	0	0	9	38	0	1	0	51	51	46
1995	0	0	0	5	1	120	23	3	4	155	155	63
1996	0	0	0	0	0	15	23	27	49	113	113	51
1997	0	0	0	0	2	53	0	0	0	55	55	76
1998	0	0	0	1	0	0	47	50	3	101	101	56
1999	0	1	5	23	5	1	17	1	0	48	53	47
2000	0	51	99	76	54	21	9	2	46	258	357	23
2001	0	0	15	125	30	56	178	98	100	588	603	23
2002	0	0	13	54	74	41	1489	42	150	1850	1863	46
2003	0	18	111	315	8	264	453	118	46	1221	1332	26
2004	0	0	496	46	7	176	680	685	305	1898	2394	28

Table 15. Starry skate (*Raja radiata*). Abundance indices (‘1000) for West Greenland with 95% confidence limits in percent of the stratified mean. () incomplete coverage of survey area.

Year	1AN	1AS	1AX	1BN	1BS	1C	1D	1E	1F	Westgr-1AX	Westgr.	CI
1991	389	765	969	1495	918	526	156	*	*	(4249)	(5218)	24
1992	2949	1323	1276	1412	243	610	1002	141	21	7699	8975	25
1993	676	356	800	1630	493	903	470	586	218	5202	6131	21
1994	1853	1799	1208	3941	1837	2814	394	170	42	12852	14060	21
1995	2735	1295	841	2762	1841	656	2421	453	84	12249	13090	26
1996	4564	2243	1525	3974	390	661	577	10	629	13045	14570	23
1997	4581	1431	649	4422	208	2279	692	83	43	13741	14390	26
1998	2765	4053	3187	3003	348	611	880	396	270	12323	15510	25
1999	1675	3172	868	2757	276	1016	818	210	197	10122	10990	23
2000	2081	3394	2035	4032	541	607	488	138	563	11845	13880	23
2001	3198	1184	566	2344	263	429	457	127	215	8215	8781	32
2002	511	1132	878	2150	383	902	2648	224	479	8428	9306	25
2003	3949	2384	1385	7162	86	720	805	186	691	15975	17370	26
2004	2468	1295	1254	1236	215	214	722	188	63	6625	7879	24

Table 16.Starry skate (*Raja radiata*). Biomass (tons) for West Greenland with 95% confidence limits in percent of the stratified mean. () incomplete coverage of survey area.

Year	1AN	1AS	1AX	1BN	1BS	1C	1D	1E	1F	Westgr-1AX	Westgr.	CI
1990	0	8	*	16	1	62	155	*	*		(243)	51
1991	81	363	167	196	113	64	232	*	*	1049	(1216)	28
1992	370	268	162	226	37	57	113	32	5	1109	1271	20
1993	60	65	199	171	87	116	128	40	22	688	887	24
1994	494	283	182	465	275	311	55	61	3	1947	2129	23
1995	253	227	301	451	327	121	300	78	24	1782	2083	21
1996	631	554	623	509	61	105	65	0	207	2131	2755	23
1997	830	411	322	566	56	156	187	25	7	2237	2559	26
1998	392	839	535	427	78	38	114	81	76	2045	2580	26
1999	278	931	253	247	45	94	96	25	49	1766	2019	34
2000	323	1178	345	428	122	84	120	3	197	2454	2799	23
2001	325	215	222	248	52	52	89	10	60	1050	1272	28
2002	13	246	320	280	101	86	687	63	177	1653	1973	29
2003	1005	902	567	1481	11	107	174	24	206	3909	4478	25
2004	598	520	791	197	47	33	333	98	78	1903	2694	23

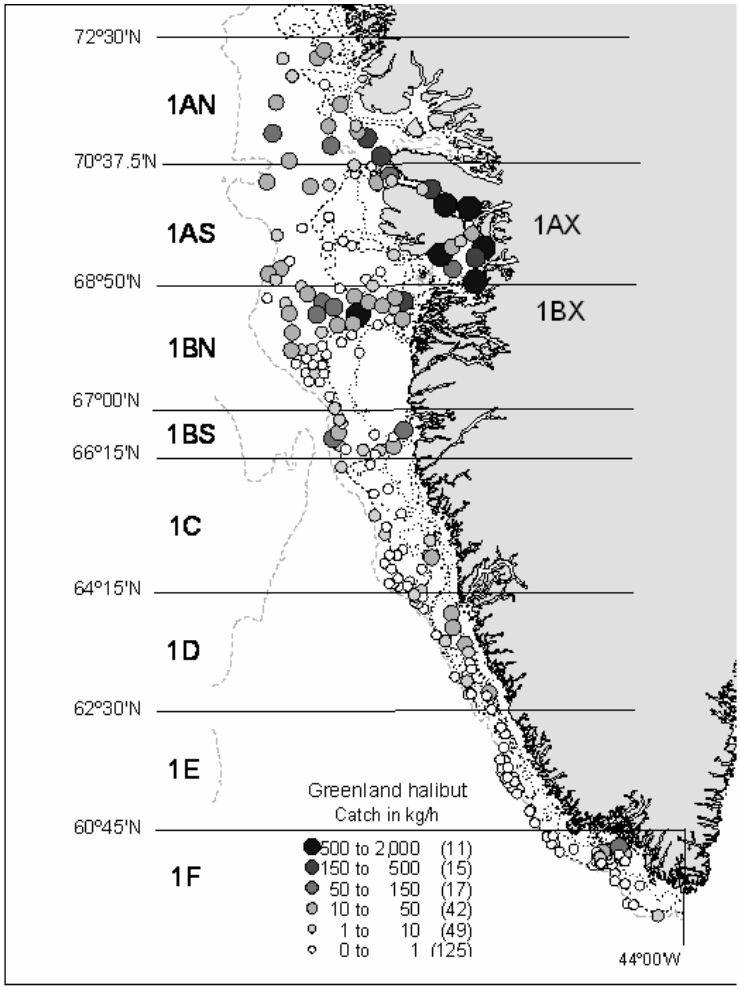

Fig. 1. Distribution of 2004-survey catches (kg/hour) of Greenland halibut (all hauls). The 200, 400 and 600 m depth contour lines are shown.

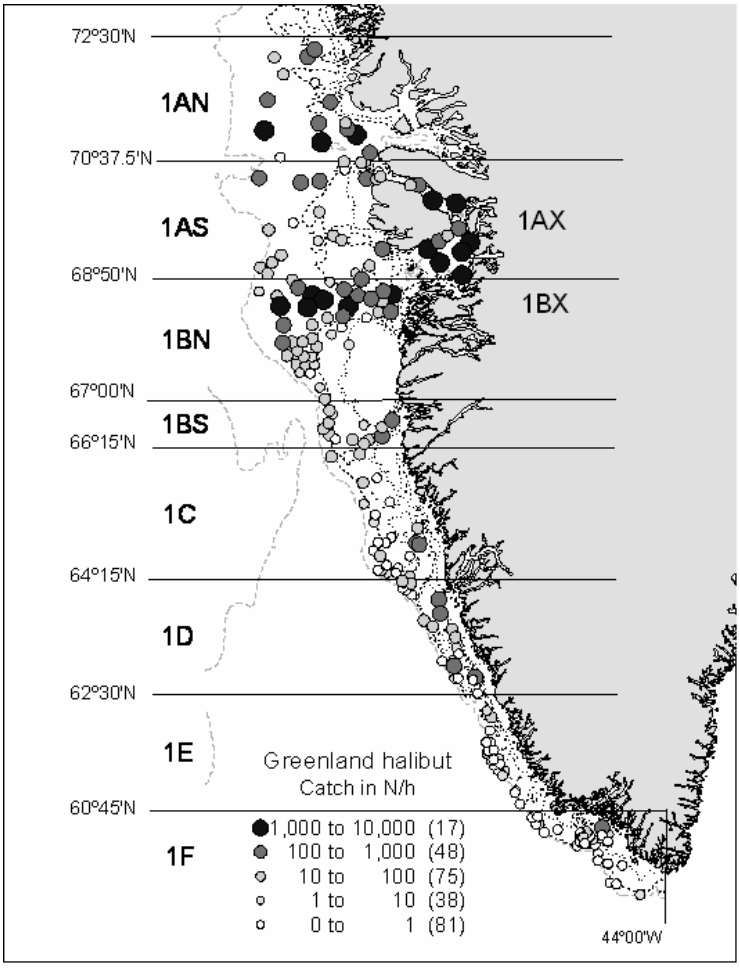

Fig. 2. Distribution of 2004-survey catches (Numbers/hour) of Greenland halibut (all hauls). The 200, 400 and 600 m depth contour lines are shown

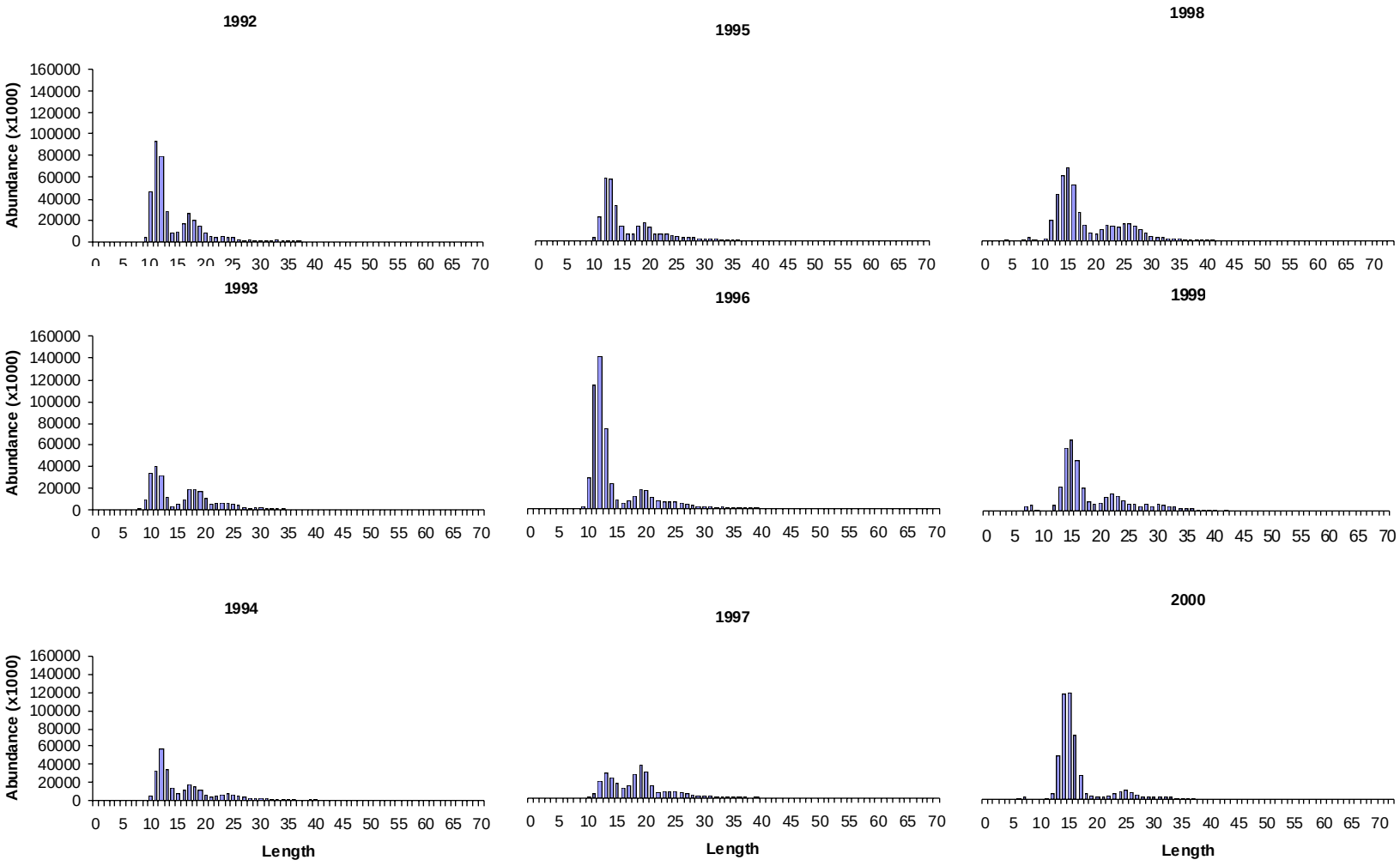

Fig. 3. Greenland halibut (*Reinhardtius hippoglossoides*). Length frequencies for West Greenland, 1991-1999.

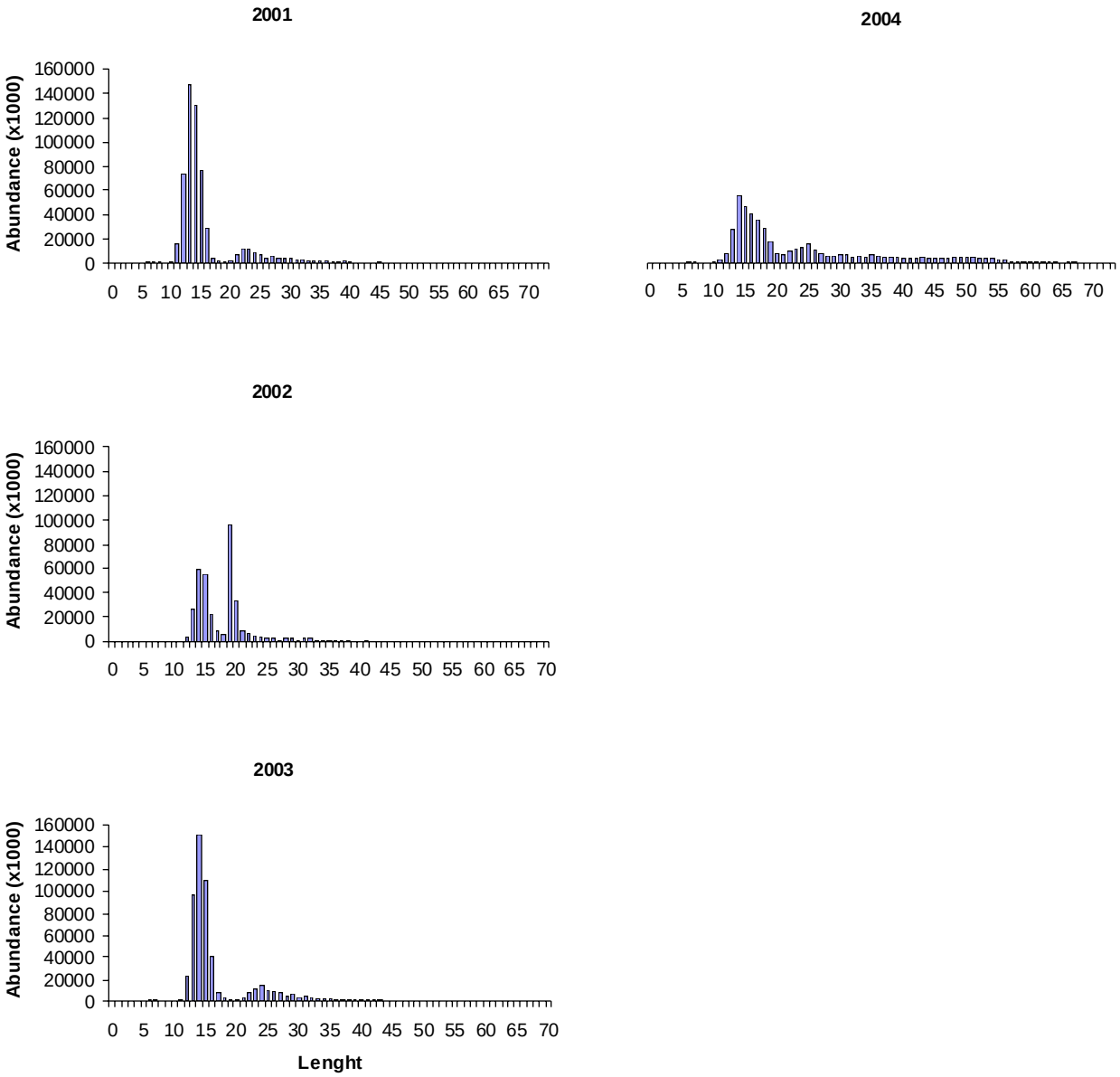

Fig. 3 cont. Greenland halibut (*Reinhardtius hippoglossoides)*. Length frequencies for West Greenland, 2001-2004.

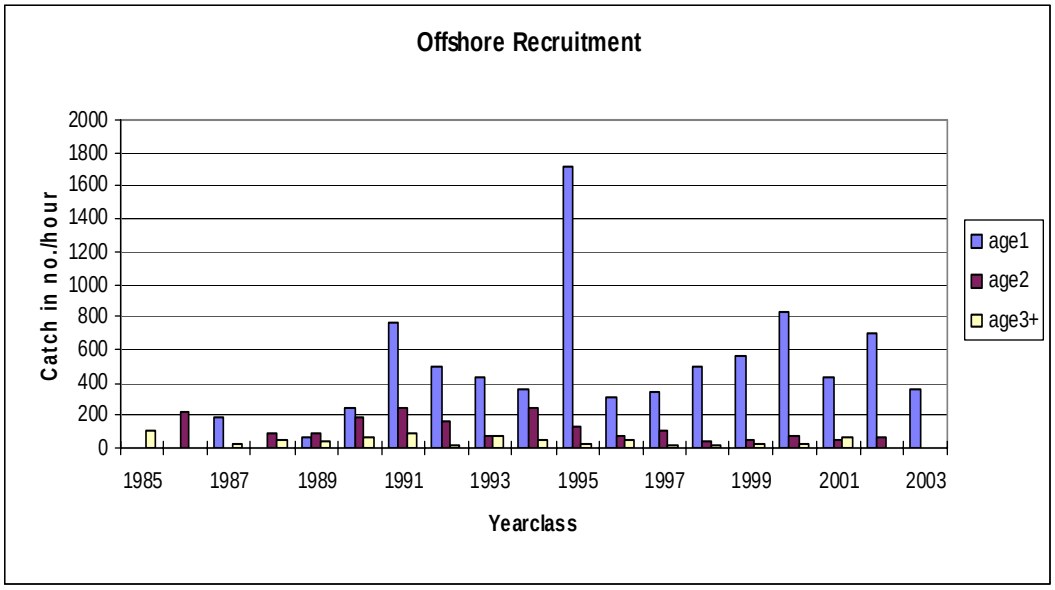

Fig. 4a. Catch in number per hour of Greenland halibut at age 1, 2 and 3+ in the offshore nursery area (1AS-1B).

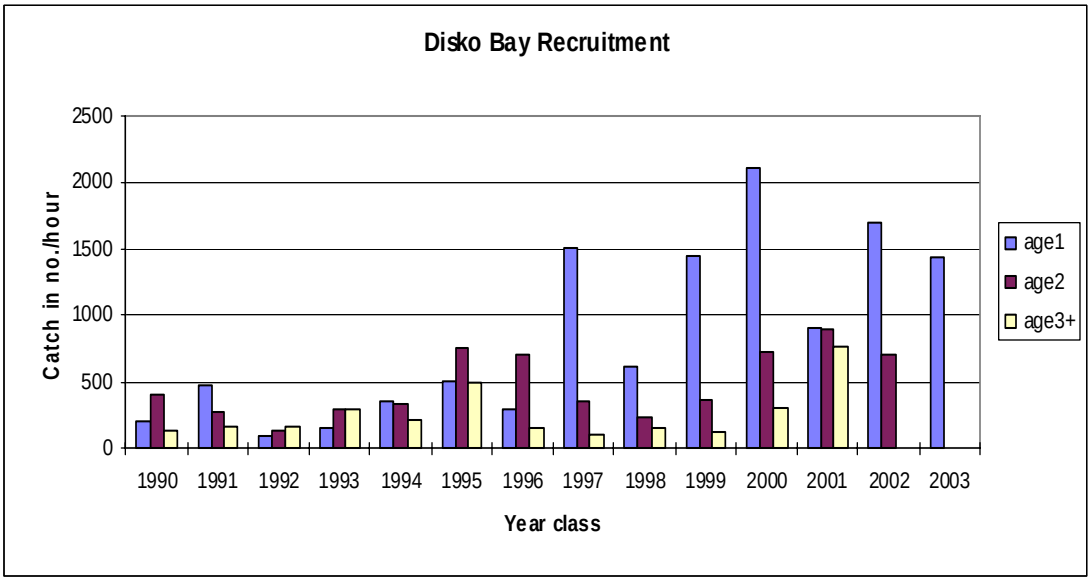

Fig. 4b. Catch in number per hour of Greenland halibut at age 1, 2 and 3+ in the in the inshore Disko Bay.

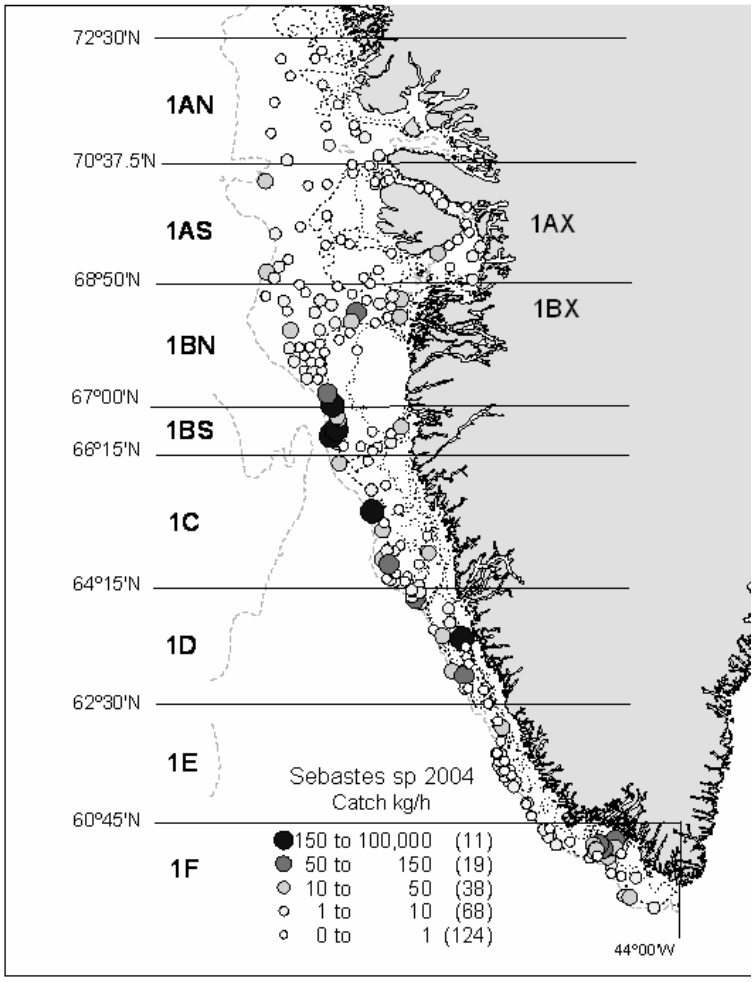

Fig. 5. Distribution of 2004-survey catches (kg/hour) of redfish sp. (all hauls). The 200, 400 and 600 m depth contour lines are shown.

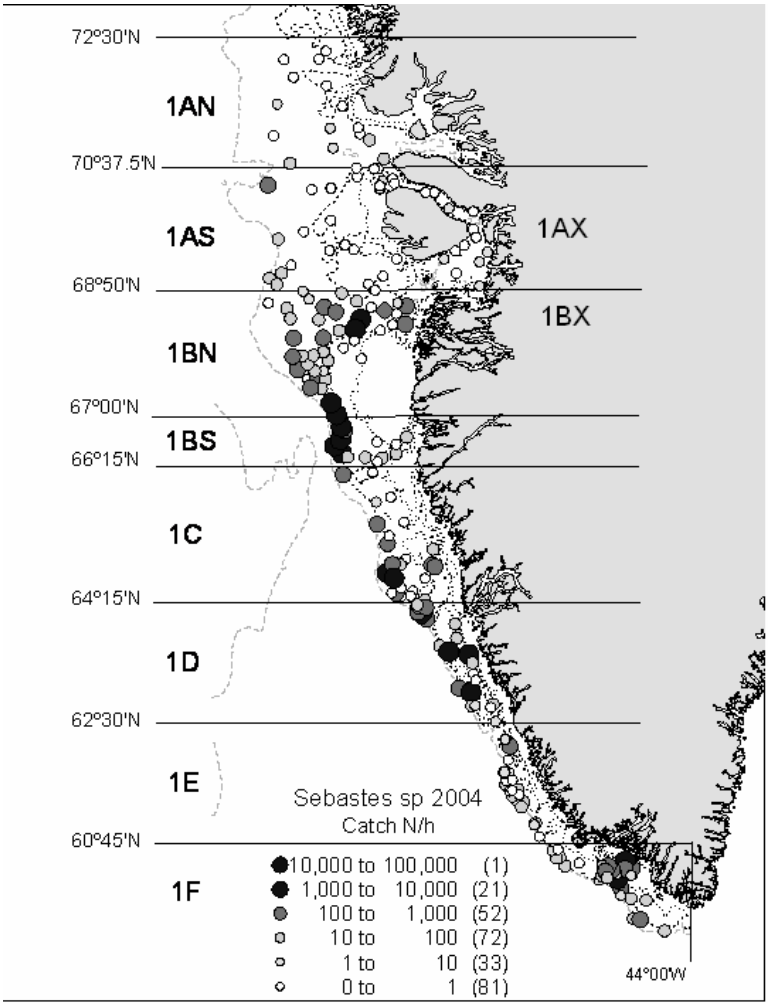

Fig. 6. Distribution of 2004-survey catches (number/hour) of redfish sp. (all hauls). The 200, 400 and 600 m depth contour lines are shown.

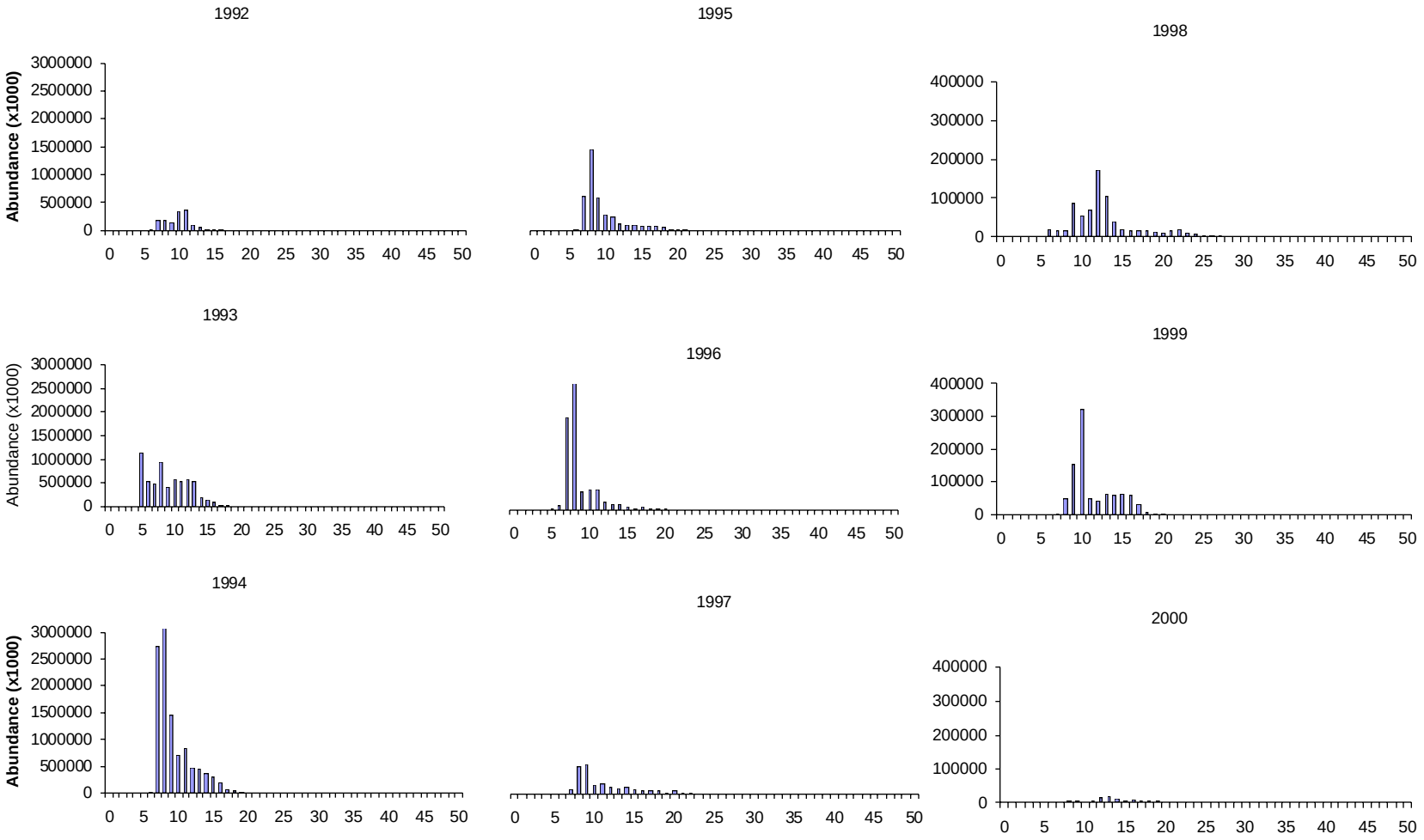

Fig. 7. Redfish (*Sebastes sp.*). Length frequencies for West Greenland, 1992-2000. From 1998 the scale has changed.

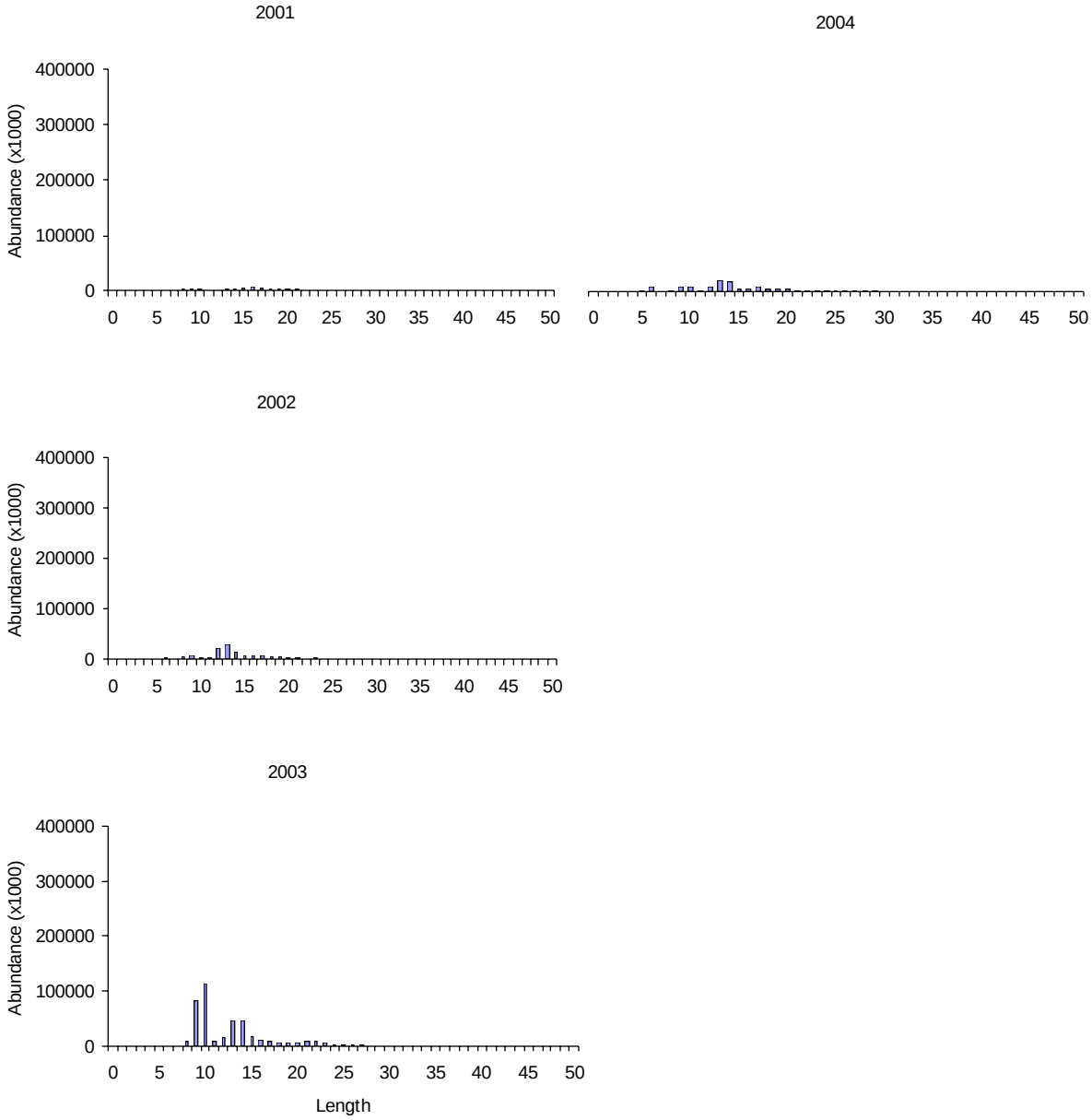

Fig. 7 cont. Redfish (*Sebastes sp.*). Length frequencies for West Greenland, 2001-2004. Notice that the scale has changed compared to the years 1992-1997

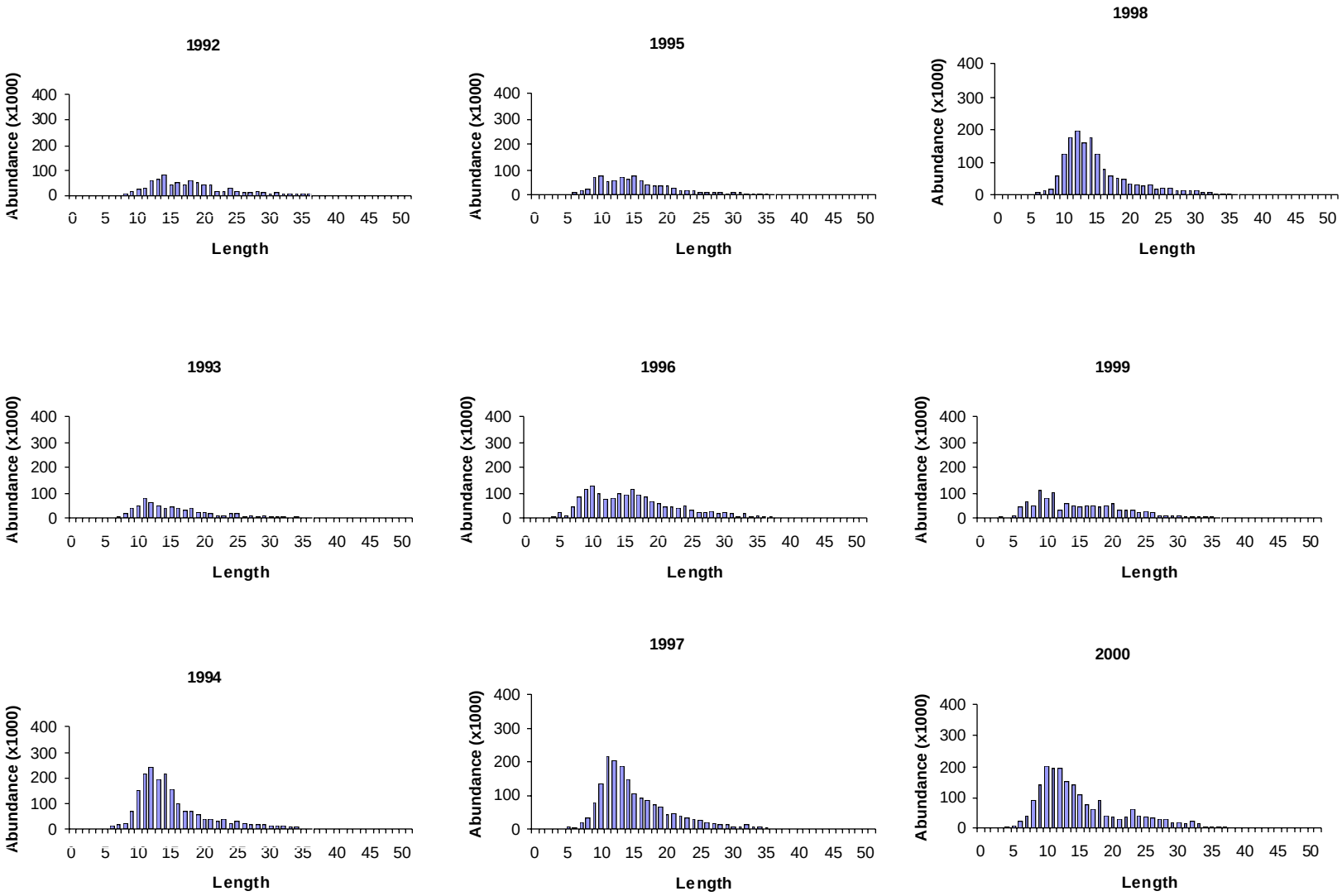

Fig. 8. American place (*Hippoglossoides platessoides*). Length frequencies, 1992-2000.

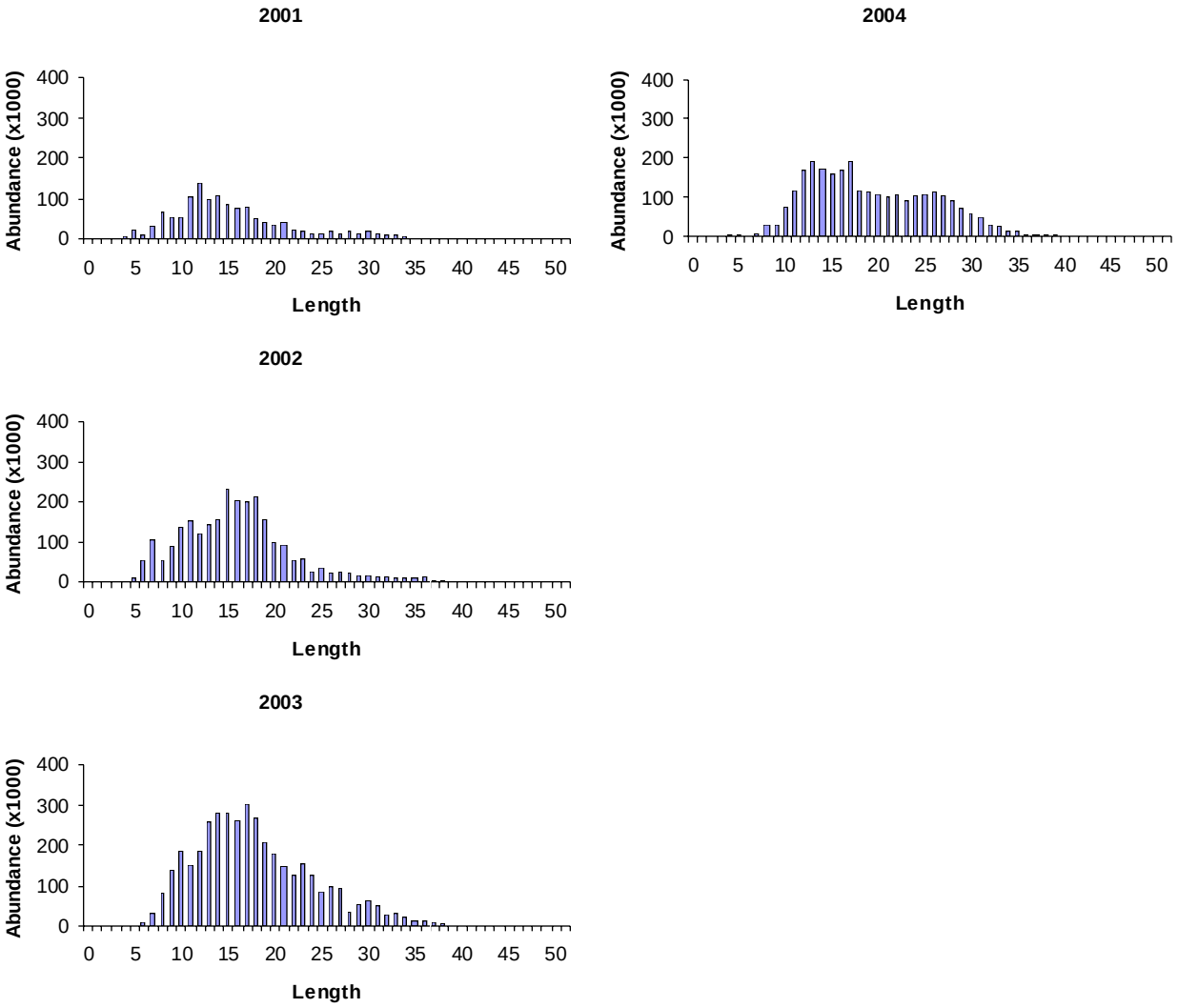

Fig. 8 cont. American place (*Hippoglossoides platessoides*). Length frequencies, 2001-2004

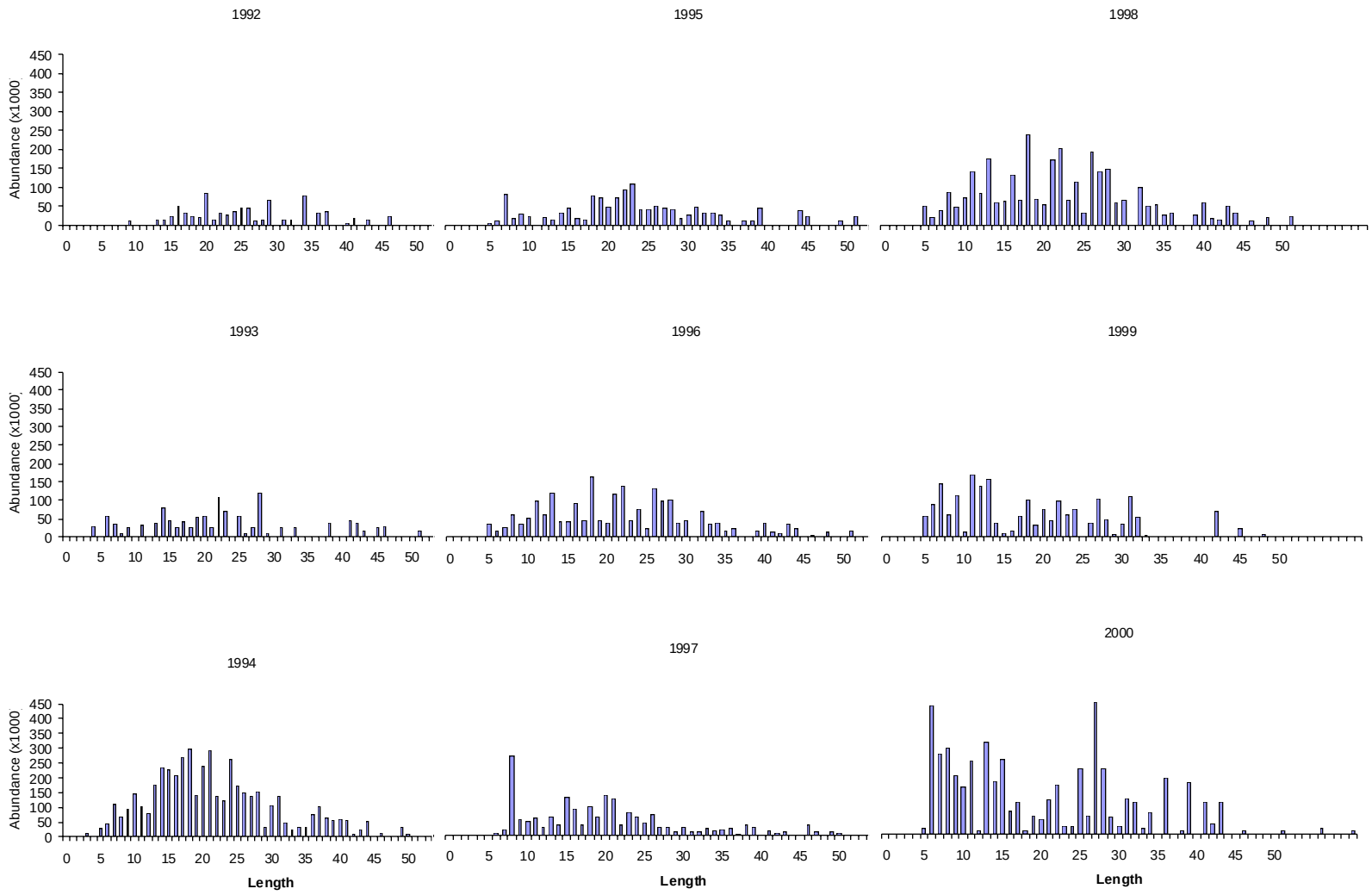

Fig. 9. Atlantic wolfish (*Anarhichas lupus*). Length frequencies for West Greenland 1992-2000.

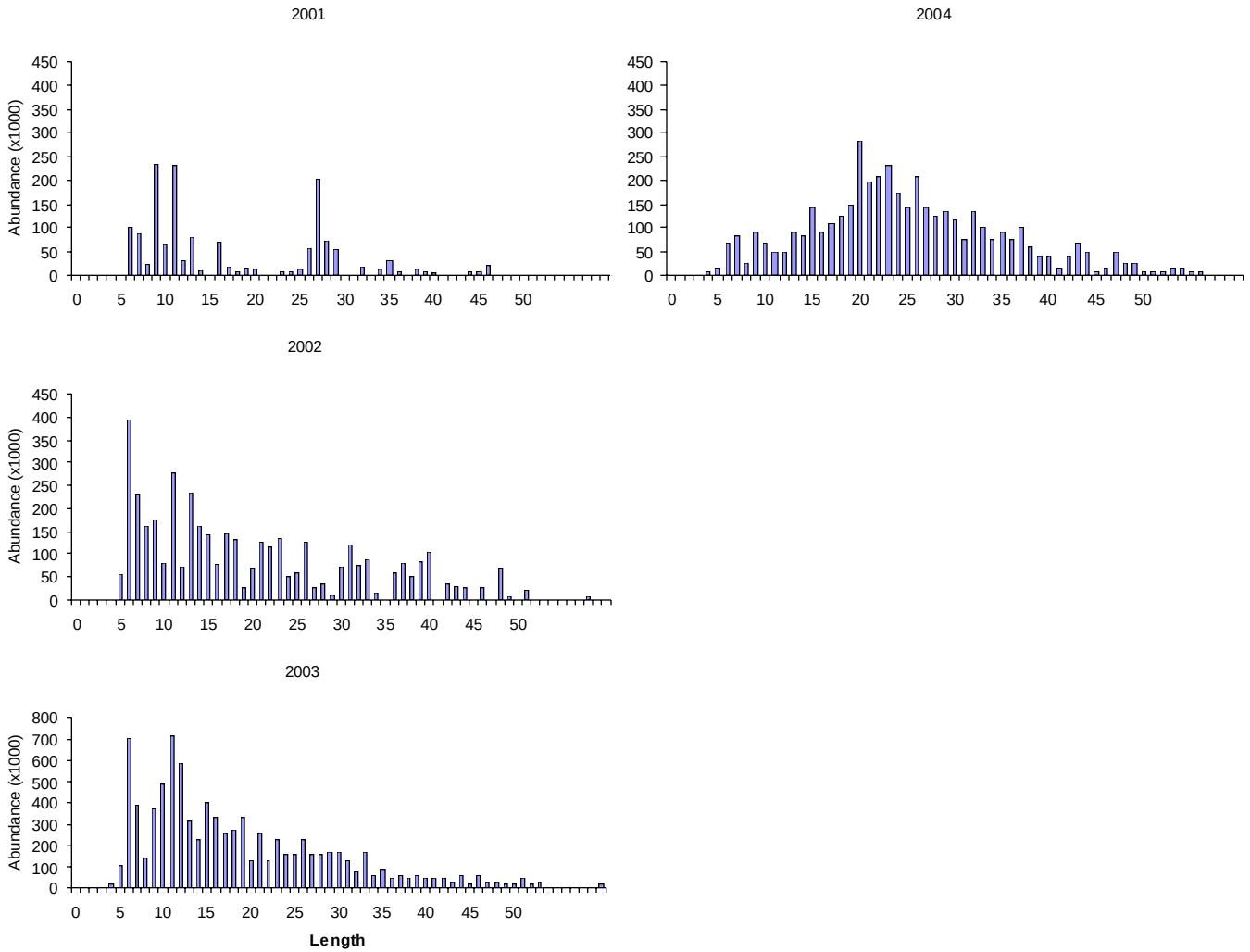

Fig. 9 cont. Atlantic wolfish (*Anarhichas lupus*). Length frequencies for West Greenland 2001-2004. Notice the scale has changed in 2003.

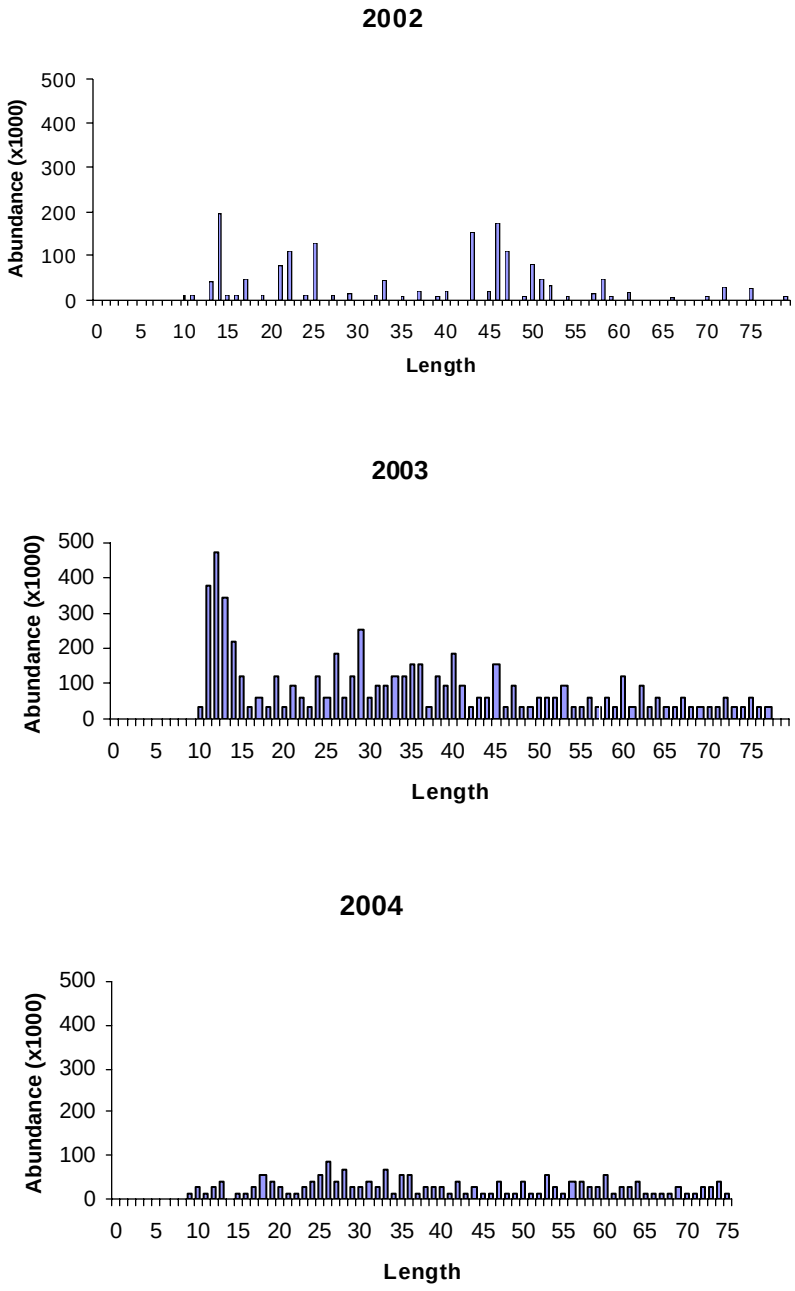

Fig. 10. Spotted wolffish (*Anarhichas minor*). Length frequencies for West Greenland 2002-2004. Length frequencies before 2002 are excluded due to very few observations.

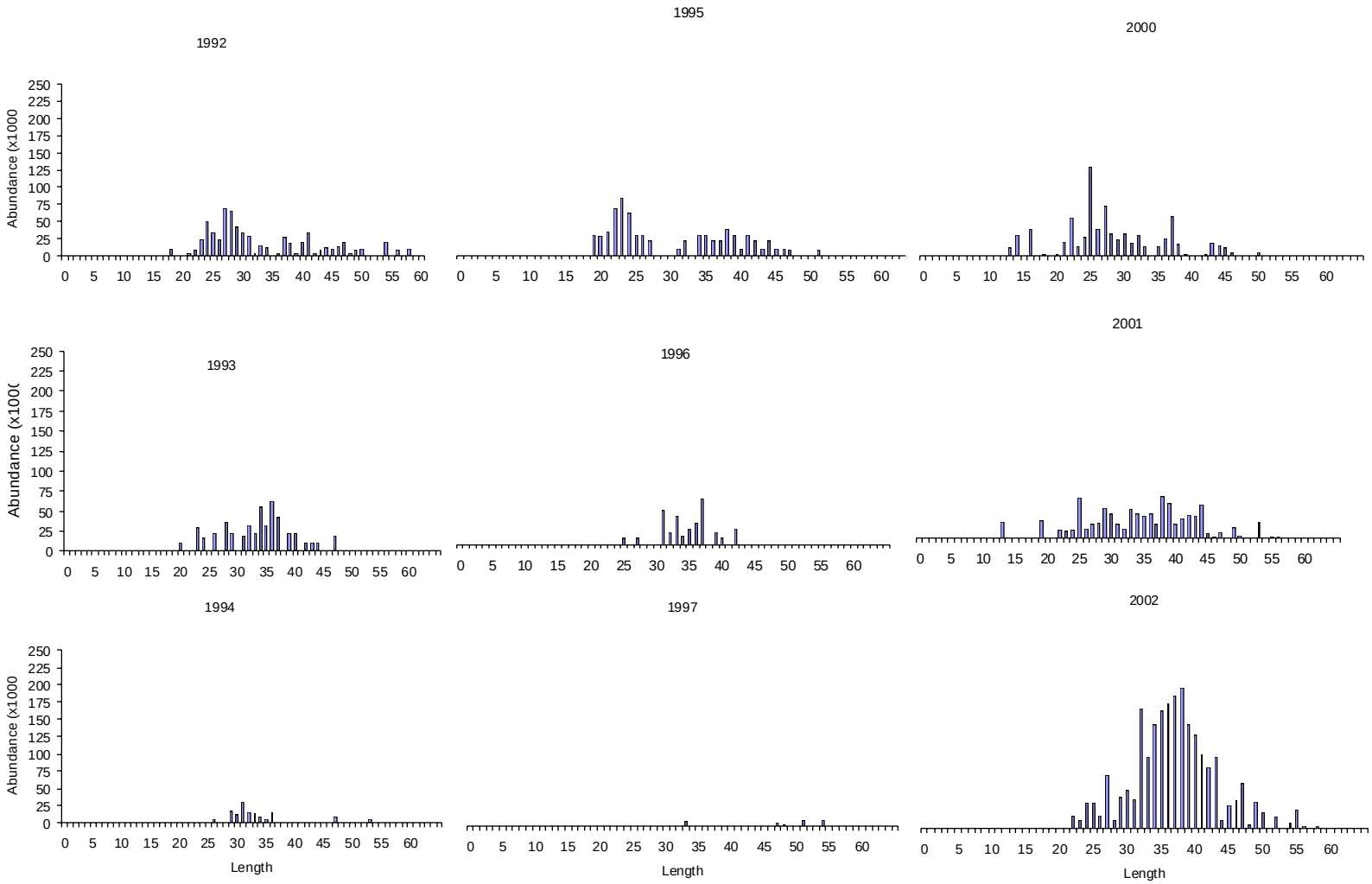

Fig. 11. Atlantic cod (*Gadus morhua*). Length frequencies for West Greenland 1992-2002. 1998 and is 1999 excluded due to very few observations.

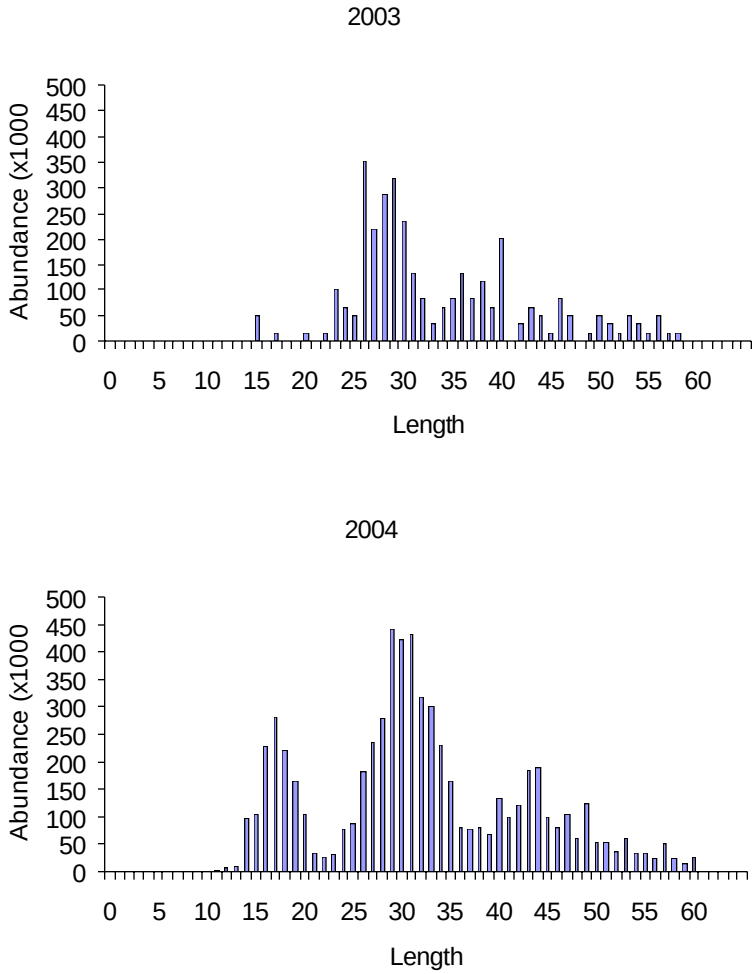

Fig. 11 cont. Atlantic cod (*Gadus morhua*). Length frequencies for West Greenland 2003-2004. Notice the scale has changed in 2003 and 2004 compared to 1992-2000.