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Biomass and Abundance of Demersal Fish Stocks off West Greenland Estimated from the Greenland Shrimp Survey, 1988-2003.

by

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Abstract

Since 1988 Greenland Institute of Natural Resources annually has 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 most fish spices have been recorded. This paper presents biomass and abundance estimates together with length frequencies of cod, Greenland halibut, redfish, wolffishes, American plaice and starry skate from the 2003 survey. 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°00'N from the 3-mile limit to the 600 m depth contour line and the inshore area Disko Bay (Fig. 1 and Table 1). The survey area is divided into NAFO Divisions, which were further subdivided into three depth strata (150-200, 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 lack of information of the bottom topography Div. 1AN and Disko Bay are considered as two single strata. Numbers of stations have been fluctuating between 78 and 278 per year, and the total number of valid hauls in 2003 was 197. 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. In Disko Bay (1AX) the trawling time is 30 min. 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), 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 it was most common in Div. 1AN-1BN and in the Disko Bay. In 2003 the biomass and abundance was estimated to 440 million individuals and 32260 tons (Tables 3 and 4). Distribution of survey catches in number pr. hour and kg pr. hour are shown in Fig. 1 and Fig. 2 for 2003. The increase in abundance were especially found in Div. 1AX (Disko Bay) and 1BN. The abundance and biomass estimates in the period 1992-2000 (except in 1996) have been relatively stable with 240-350 mill individuals and 11 000-26 000 tons. In 1996 the abundance increased to 603 mill. individuals, witch is the largest figure in the time series. The biomass shows a slight increasing trend during the time series.

The length distribution ranged between 6 and 67 cm with the main caches below 35 cm and two clear modes around 13 cm and 23 cm (Fig. 3).

The CPUE (number per hour of age 1 (2002 year-class)) was estimated to 701.9 specimens in the offshore nursery area (Div. 1AS, 1BN and 1BS), which is well above average for the time series (516). In the Disko Bay the CPUE was estimated at 1704.7 specimens of age one per hour, which is the second largest in the time series (Fig. 4). The abundance of 2-year olds is generally lower in the offshore area in comparison to the Disko Bay. But there is generally a steep decline in the CPUE of fish age one and fish age two the following year in both areas. The 2001 year-class in the Disko Bay was, as age two, however, the largest on record.

Redfish (*Sebastes sp.*).

Redfish was found in all the survey areas, but was most common in Div. 1BN and 1C. 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 1.1-2.8 billion individuals and 12 000-31 000 tons. From 1997 – 2003 biomass has been decreasing to between 122-763 millions individuals and 10-20 000 tons. After reaching a historic low in 2001 biomass and abundance has increased to 409 millions individuals and 21 000 tons in 2003 (Tables 5 and 6). This increase is particular distinct for Div. 1BN and 1C.

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 2003 two 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 2003 the biomass and abundance was estimated to 92 million individuals and 4 700 tons, which is the largest values in the time series (Tables 7 and 8). Especially Div. 1BN and 1C has experienced a large increase. The abundance and biomass estimates for American plaice has varied between 9 and 92 millions individuals and 614 and 4 700 tons, with an increase the latest years. In 2003 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 the largest abundance were found in 1BN (Tables 9 and 10). In 2003 the abundance and biomass was estimated to 15.6 million individuals and 1 850 tons. The latest years an increase has been evident and the values in 2003 are the highest in the time series. The abundance and biomass has from 1992-2001 varied through the time series without any significant trend with highest estimates in 1994 (6.7 million individuals and 977 tons) and lowest in 1993 (1.0 million individuals and 228 tons).

In 2003 the length ranged between 5 and 55 cm (Fig. 9). The analysis of the length distribution reveals the dominance of small fish < 35 cm with peaks at 8-12 cm 14-17 cm and 25-30 cm.

Spotted wolffish (*Anarhichas minor*)

Spotted wolffish is distributed in all survey areas, in 2003 mainly in 1AN and 1BN. In 2003 the biomass and abundance was estimated to 6 million individuals and 4 500 tons (Tables 11 and 12), as was the case with the Atlantic wolffish it is the highest estimate in the time series. The abundance and biomass has varied through the time series but has been increasing since the historic low in 1999 with a biomass estimate at 390 tons.

Only in the last two years enough spotted wolffish were caught in the survey to reveal meaningful length distributions. In 2003 the length ranged from 10-75 cm with a clear mode is evident at 10-15 cm but thereafter the peaks are somewhat more difficult to follow (Fig. 10).

Cod (*Gadus morhua*)

Cod was captured in all areas during the 2003 survey. Since 1999 larger part of the catches have been caught in 1AX and 1BN and for the first time in 11 years cod were in 2003 also caught in 1AN. Tables 13 and 14 list abundance and biomass indices of cod by stratum. The biomass-indices for cod were estimated to 4 000-7 000 tons in 1988-1990. In 1992 the biomass decreased with over 95% to only 250 tons and 528 000 individuals and remained at this low until recent years. There are indications of a slight improvement in the abundance of small cod. Abundance indices in 2003 were estimated to 3.7 million individuals and biomass to 1 500 tons, which is the 2.highest estimate in time series.

Figure 11 gives the length distribution of cod in the survey during the years. The lengths range between 15 and 60 cm with distinct modes at 22-25, 26-32 and 34-40 in the 2003 survey.

Starry skate *(Raja radiata*)

The biomass distributed in all survey areas, but in 2003 the main catches were in the northern parts 1AN and 1BN. The abundance and biomass of starry skate have during the years been fluctuating without any significant trend between 6-16 million individuals and 1 000-2 600 tons in 1991-2002. In 2003 the abundance and biomass increased to 24.6 mill. individuals and 6 000 tons, the highest in the time series (Tables 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 short time series and the high variability on estimates calls for some reservations. Three successive years of low recruitment to the redfish stock was in 2003 followed by an increase in abundance. 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 20 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 two, 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 the picture has somewhat changed, as an increase is evident in all species mentioned in this paper. Four of the species; American plaice, Atlantic wolfish, spotted wolffish and starry skate has in 2003 the highest estimated abundance during the time series. A large part of the increase is 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 22mm 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.

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

Stratum					depth	area
	south	north	east	west	(m)	(km^2)
1AN*	70º37.5'N	72º00 'N	55º30'W	57º00'W	1-600	41129
1AS	68º50 'N	70º37.5'N	54º15'W	57º00'W	1-200	4681
-					200-400	7474
-					400-600	640
1AX*	68º07.5'N	70º37.5'N	51º00'W	54º00'W	1-600	9364
1BN	67º00'N	68º50'N	5000'W	59º45'W	1-200	16093
-					200-400	17370
-					400-600	4133
1BS	66º15'N	67º00'N	50º00'W	57º00'W	1-200	7722
-					200-400	1682
-					400-600	1243
1C	64º15'N	66º15'N	48º00'W	57º00'W	1-200	17916
-					200-400	5314
-					400-600	3366
1D	62º30'N	64º15'N	48º00'W	54º00'W	1-200	8921
-					200-400	3562
-					400-600	903
1E	60º45'N	62º30'N	44º00'W	52º00'W	1-200	7871
-					200-400	2000
					400-600	329
1F	59º15'N	60º45'N	44º30'W	50º00'W	1-200	8808
-					200-400	3330
-					400-600	1211
Total West Greenland						165698

* No depth stratification in Div. 1AN and Disko Bay

Table 2. Numbers of valid hauls, 1988-2003. 1AX=Disko Bay.

Year	1AN	1AS	1AX	1BN	1BS	1C	1D	1E	1F	Westgr.-1AX	Total
1988	23	14	*	25	5	7	4	*	*		78
1989	37	11	*	60	13	21	2	*	*		144
1990	28	20	*	69	17	35	21	*	*		190
1991	*	11	47	54	17	11	9	*	*	102	149
1992	32	16	44	42	8	18	20	11	17	163	207
1993	23	13	32	44	10	21	16	14	14	155	187
1994	28	19	30	52	10	24	10	10	9	162	192
1995	29	17	37	53	13	29	15	14	11	181	218
1996	22	12	36	52	11	29	12	9	11	158	194
1997	29	17	37	110	9	32	13	12	19	241	278
1998	20	20	36	68	14	27	19	14	15	197	233
1999	20	26	37	64	18	33	16	14	17	208	245
2000	18	13	23	59	17	37	23	14	28	209	232
2001	18	16	23	63	16	36	24	13	26	211	234
2002	12	13	24	69	12	32	18	20	25	201	225
2003	21	10	18	51	12	30	18	15	22	179	197

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
1988	103500	2697		110900	7572	2140	194	*	*		(251263)	26
1989	*	*	*	*	*	*	*	*	*		*	*
1990	21730	1290	*	58310	4920	950	297				(83070)	24
1991	*	508	25980	58710	2972	1308	1821	*	*	(65320)	(91300)	25
1992	31920	4100	68690	235900	1599	1230	568	594	0	275866	344556	27
1993	28170	14290	35240	174100	10230	4295	3910	3517	427	238921	274161	32
1994	21780	24490	43760	170500	12050	20720	133	397	559	252884	296644	27
1995	18900	11320	83220	111100	22830	14320	5651	201	339	184655	267875	21
1996	118100	2049	111500	326500	13530	18700	11790	129	355	491232	602732	22
1997	32430	3019	126500	61590	2615	14520	783	57	273	115251	241751	20
1998	54490	5898	181500	71840	28370	8360	4109	1323	658	175100	356600	22
1999	63010	7854	94400	106800	6426	5617	7602	1043	983	199300	293700	18
2000	50570	10440	160100	109800	4728	5415	8059	187	589	189800	349900	23
2001	79940	89150	201100	147500	1838	6099	2910	597	1673	329700	530800	21
2002	75450	59270	94800	52660	3438	8029	7180	556	1287	207873	302673	25
2003	99150	3608	189700	136000	2818	2761	4391	87	1015	249800	439500	26

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
1988	9334	1012	*	5955	1416	1009	85	*	*		(18810)	25
1989	1342	294	*	1364	85	333	*	*	*		*	*
1990	2543	251	*	4384	278	271	174	*	*		(7901)	19
1991	*	5	2147	1705	88	286	70	*	*		(4301)	19
1992	2980	161	3802	4715	377	270	70	46	0	8620	12422	19
1993	2558	252	2364	3617	757	587	449	121	44	8285	10649	23
1994	2069	849	2488	4407	1799	1786	99	11	27	11046	13534	26
1995	1627	168	5053	2305	949	1178	459	6	46	6738	11791	19
1996	4363	41	8047	7204	508	1575	959	8	114	14772	22819	21
1997	3195	284	7723	3450	495	1941	164	14	89	9631	17354	19
1998	4824	417	12500	4121	1940	1089	300	105	317	13111	25611	20
1999	6006	376	8117	6437	704	879	245	35	339	15020	23137	20
2000	1815	320	9608	4142	536	783	619	24	287	8525	18133	18
2001	5942	1494	10552	5064	318	1444	315	18	460	15339	25891	22
2002	5769	1746	8838	4145	956	928	837	37	407	14825	23663	22
2003	7164	277	16171	6823	503	654	305	3	361	16090	32261	27

Table 5. Redfish (*Sebastes sp.*). Abundance indices (x100000) 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	76	457	62	10320	2052	558	291	54	65	13877	13939	33
1993	92	283	58	4081	224	1733	1899	6600	2485	11400	11458	29
1994	485	891	125	17470	3578	2912	1023	127	1189	27680	27805	26
1995	569	233	104	6048	560	2163	952	46	52	10622	10726	22
1996	25	40	55	19800	661	1185	674	107	631	24427	24482	29
1997	119	163	46	3950	717	1763	487	232	156	7587	7633	25
1998	84	72	145	2415	176	915	808	72	364	4906	5051	20
1999	399	138	70	2099	62	1186	484	30	182	4580	4649	18
2000	26	112	18	656	315	305	85	152	175	1824	1842	23
2001	80	94	13	249	149	216	199	10	213	1210	1223	24
2002	8	49	8	562	1118	455	462	14	99	2766	2774	30
2003	60	75	9	2174	368	894	250	17	238	4076	4085	21

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
1989	554	164	*	5110	2381	2307	2180	*	*		(12690)	30
1990	882	1908	*	7373	471	1753	710	*	*		(13077)	19
1991	*	13	242	7261	408	1091	1421	*	*	10195	(10437)	23
1992	279	490	330	13970	2928	1419	837	76	279	20279	20609	28
1993	309	701	270	6904	330	1327	2232	652	1119	13573	13843	31
1994	1604	2138	451	17303	2912	4063	883	200	1519	30172	30623	45
1995	1225	231	569	4178	1012	2618	1982	256	68	11570	12139	22
1996	40	61	495	14879	1727	3015	2161	284	1964	21613	22108	27
1997	618	515	277	6069	1879	7457	1708	737	677	19659	19937	32
1998	428	443	622	9290	2554	3561	2189	392	1336	20192	20814	20
1999	1121	624	467	5878	188	1928	1586	123	752	12201	12668	20
2000	80	427	98	2005	2074	2500	307	1609	934	9935	10033	30
2001	441	647	247	2408	1706	3102	1060	60	2388	11813	12060	28
2002	55	330	214	3216	2895	1787	2728	218	989	12218	12432	27
2003	749	445	262	7129	2494	6440	1819	147	2269	21491	21753	31

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	*	460	535	3630	506	3659	3412	*	*	11669	(12204)	43
1992	1297	421	1569	1618	629	1820	1267	683	112	7846	9415	25
1993	1577	315	1071	3477	964	2147	1817	497	725	11518	12589	23
1994	3272	1493	3181	20950	7001	10420	819	441	694	45088	48269	27
1995	1068	283	1733	6365	1193	2812	3863	589	572	16745	18478	23
1996	2174	607	8072	5776	2602	4599	4732	251	751	21492	29564	21
1997	5818	776	2489	9452	1137	12330	2831	466	858	33666	36155	21
1998	1414	818	2064	4671	1992	1864	8382	787	2122	22056	24120	21
1999	569	856	1633	8968	1818	5925	2128	722	689	21677	23310	16
2000	1222	4003	5067	17390	2007	4110	5803	391	565	35483	40550	22
2001	1268	1187	1320	14180	1871	5140	3741	524	609	28480	29800	26
2002	230	3597	2839	10150	2372	7246	29410	1562	1933	56501	59340	27
2003	3637	3019	4144	30180	1871	28300	17480	915	2724	88116	92260	23

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
1989	38	53	*	151	111	392	64	*	*		(810)	29
1990	0	0	*	120	48	145	364	*	*		(677)	40
1991	*	5	89	118	58	160	380	*	*	105	(194)	64
1992	52	11	126	84	53	140	118	65	7	530	656	26
1993	68	25	71	97	36	101	137	47	32	543	614	28
1994	140	96	285	599	343	316	66	32	74	1666	1951	23
1995	82	17	264	211	61	97	167	35	17	687	951	20
1996	158	48	715	264	95	158	161	12	30	927	1642	20
1997	331	29	315	227	99	420	146	37	29	1318	1633	17
1998	142	33	347	241	74	100	468	83	102	1243	1590	18
1999	80	36	159	361	72	230	156	45	54	1034	1193	23
2000	103	196	373	588	79	208	315	64	43	1595	1968	16
2001	155	55	114	482	81	295	227	27	47	1362	1476	15
2002	115	122	221	461	207	347	1260	93	69	2675	2896	22
2003	356	82	288	1078	149	1250	1175	65	241	4398	4686	20

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	17	4	39	2	203	107	291	213	872	876	37
1993	17	12	6	33	43	233	240	231	205	1014	1020	28
1994	17	35	16	512	263	2129	518	598	2628	6701	6717	38
1995	15	0	0	120	120	365	123	626	261	1630	1630	31
1996	0	41	6	119	134	391	361	430	725	2230	2207	30
1997	32	10	0	103	30	1063	321	442	152	2153	2153	28
1998	147	67	17	322	157	825	469	450	780	3215	3232	27
1999	0	112	65	210	276	349	254	344	236	1782	1847	41
2000	0	409	59	310	486	314	488	1054	49	3111	3170	47
2001	0	96	52	518	74	221	282	234	77	1491	1543	27
2002	230	291	27	816	15	98	64	138	64	4992	5019	30
2003	99	97	301	5972	175	2871	1563	3163	1353	15299	15600	45

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	5	<1	9	51	34	24	62	71	257	257	34
1993	7	1	1	3	3	31	45	21	116	227	228	36
1994	<1	9	6	77	59	237	45	107	436	971	977	41
1995	<1	0	0	33	10	35	36	153	40	307	307	35
1996	0	<1	4	21	52	46	56	76	120	371	375	29
1997	5	-	0	21	1	173	17	92	19	328	328	28
1998	-	1	4	12	14	74	38	79	137	355	359	33
1999	0	27	-	24	25	8	11	165	41	302	302	24
2000	0	22	-	56	41	67	41	239	17	483	483	39
2001	0	2	1	24	-	20	26	40	26	139	140	26
2002	11	7	1	143	6	138	110	281	138	834	835	33
2003	2	1	18	755	57	504	94	241	185	1838	1856	44

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	49	31	9	49	28	50	28	39	60	334	343	22
1993	61	21	14	47	41	41	29	32	33	273	287	23
1994	113	193	16	318	57	427	35	13	80	1237	1253	23
1995	176	38	7	60	52	46	34	47	35	488	495	19
1996	177	23	6	145	52	34	34	0	41	506	512	22
1997	299	18	26	101	0	39	51	0	5	513	539	33
1998	449	687	0	286	36	26	45	17	5	923	923	28
1999	558	124	57	766	110	18	4	0	0	1582	1639	26
2000	368	508	31	506	144	30	5	53	0	1615	1646	25
2001	683	171	36	295	42	46	0	0	6	1244	1280	28
2002	326	108	14	576	333	124	71	10	26	1573	1587	46
2003	1814	473	115	2556	461	989	32	0	50	5960	6075	37

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	11	65	35	85	9	37	26	11	273	517	552	35
1993	40	8	67	45	18	44	4	<1	187	346	413	58
1994	213	105	15	81	55	164	56	12	4	690	705	20
1995	65	20	14	51	19	29	20	20	196	419	433	32
1996	267	<1	9	255	25	7	34	0	60	648	657	23
1997	291	17	38	33	0	19	111	0	3	475	513	24
1998	148	9	0	280	21	7	161	53	7	686	686	23
1999	197	51	18	40	62	14	2	0	0	368	386	38
2000	37	55	30	104	35	20	1	342	0	595	625	53
2001	313	13	22	306	84	5	0	0	12	733	755	30
2002	131	135	3	274	258	145	236	70	112	1360	1363	38
2003	1021	454	117	1837	26	919	102	0	13	4372	4489	34

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	11	7	32	429	78	*	*	546	(557)	73
1992	0	0	4	16	33	242	242	0	9	543	547	45
1993	0	0	0	0	0	54	36	205	12	308	308	67
1994	0	9	0	0	54	98	0	7	0	167	167	43
1995	0	0	0	33	17	504	42	20	46	662	662	58
1996	0	0	0	0	0	47	78	66	108	298	298	40
1997	0	0	0	2	8	35	0	0	0	45	45	64
1998	0	0	0	5	0	0	25	28	4	62	62	44
1999	0	10	18	141	52	17	18	6	0	243	261	41
2000	0	188	273	311	201	86	48	9	205	1048	1321	19
2001	0	0	15	248	86	140	498	210	373	1555	1570	23
2002	0	0	9	75	172	99	3595	102	202	5245	5254	52
2003	93	53	257	142	46	423	734	469	250	3487	3744	28

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
1988	0	0	*	35	0	1230	2613	*	*		(3879)	81
1989	44	0	*	73	0	41	1002	*	*		(1217)	51
1990	4	13	*	7	7	118	6825	*	*		(7004)	45
1991	*	0	7	1	2	188	53	*	*	243	(250)	58
1992	0	0	3	22	31	74	85	0	2	214	217	44
1993	0	0	0	0	0	24	8	87	4	122	122	69
1994	0	3	0	0	12	41	0	1	0	58	58	43
1995	0	0	0	3	2	158	22	2	5	192	192	67
1996	0	0	0	0	0	16	26	21	49	112	112	41
1997	0	0	0	2	2	60	0	0	0	64	64	65
1998	0	0	0	<1	0	0	55	57	4	117	117	43
1999	0	1	4	38	5	<1	13	1	0	60	64	31
2000	0	63	65	80	60	27	6	2	56	295	360	20
2001	0	0	9	133	38	72	186	67	110	606	615	26
2002	0	0	9	59	96	52	1629	38	87	1959	1968	48
2003	16	8	76	328	9	285	459	204	54	1363	1439	29

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.
1991	*	176	22	4028	890	877	1140	*	*	(7111)	(7133)
1992	2600	387	710	3082	626	713	1404	177	21	9010	9720
1993	1022	125	552	1872	608	1162	484	401	192	5867	6419
1994	2406	636	1131	5065	2367	3279	621	308	72	14754	15885
1995	3245	170	802	3147	1243	560	3181	804	89	12438	13240
1996	5586	429	1842	4640	513	748	747	22	607	13292	15134
1997	4060	389	826	3131	249	3278	732	137	48	12024	12850
1998	4446	712	2421	3751	561	656	1096	397	269	11889	14310
1999	3651	513	879	3963	410	1110	784	193	188	10811	11690
2000	1888	1190	2689	4716	583	718	631	121	583	10021	12710
2001	3646	298	521	2829	336	579	486	119	260	8552	9073
2002	772	749	626	3148	503	1866	2827	226	524	10616	11242
2003	5010	468	964	14390	939	1532	959	244	938	23636	24600

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
1989	220	38	*	257	110	202	44	*	*		(870)	24
1990	10	1	*	272	27	224	703	*	*		(1237)	48
1991	*	12	21	252	94	101	259	*	*	718	(739)	32
1992	404	106	115	310	100	57	152	43	5	1177	1292	20
1993	83	19	147	276	89	147	123	27	17	780	927	28
1994	501	88	194	560	341	355	89	122	11	2066	2260	26
1995	397	16	299	483	401	138	335	138	25	1933	2232	22
1996	806	46	691	632	69	120	81	199	54	1955	2646	27
1997	731	68	403	324	69	200	185	24	7	1608	2011	19
1998	541	81	663	593	126	44	129	83	74	1671	2334	19
1999	633	54	308	299	67	101	103	45	50	1352	1660	22
2000	335	369	683	533	146	100	148	3	197	1800	2483	18
2001	326	91	219	289	61	65	88	6	79	1005	1224	17
2002	33	148	203	407	131	118	692	67	189	1785	1988	20
2003	1852	64	382	3126	12	183	173	36	305	5751	6133	44

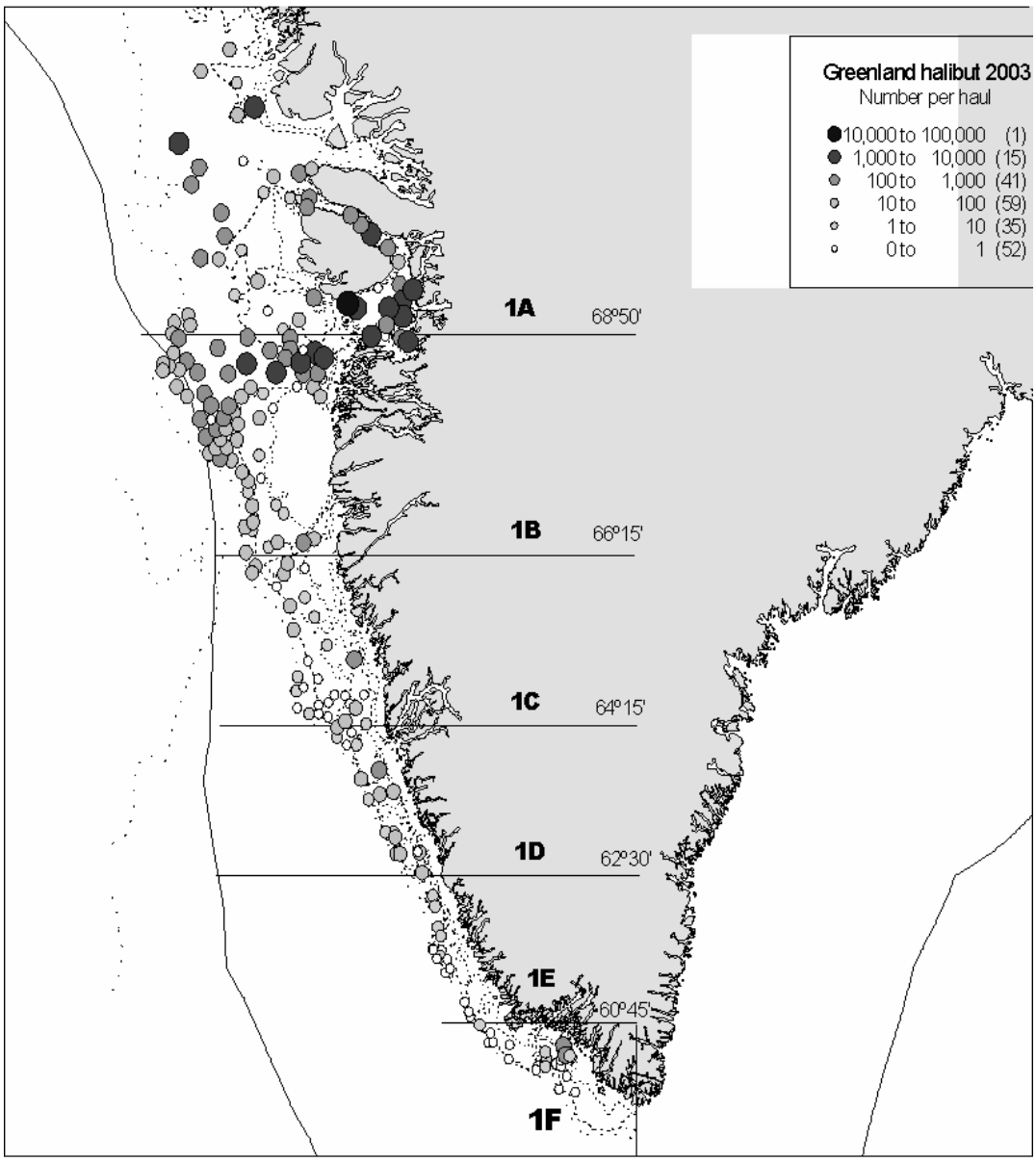

Fig. 1. Distribution of 2003-survey catches (number/hour) of Greenland halibut (all hauls). The midline against Canada and 200, 400 and 600 m depth contour lines are shown.

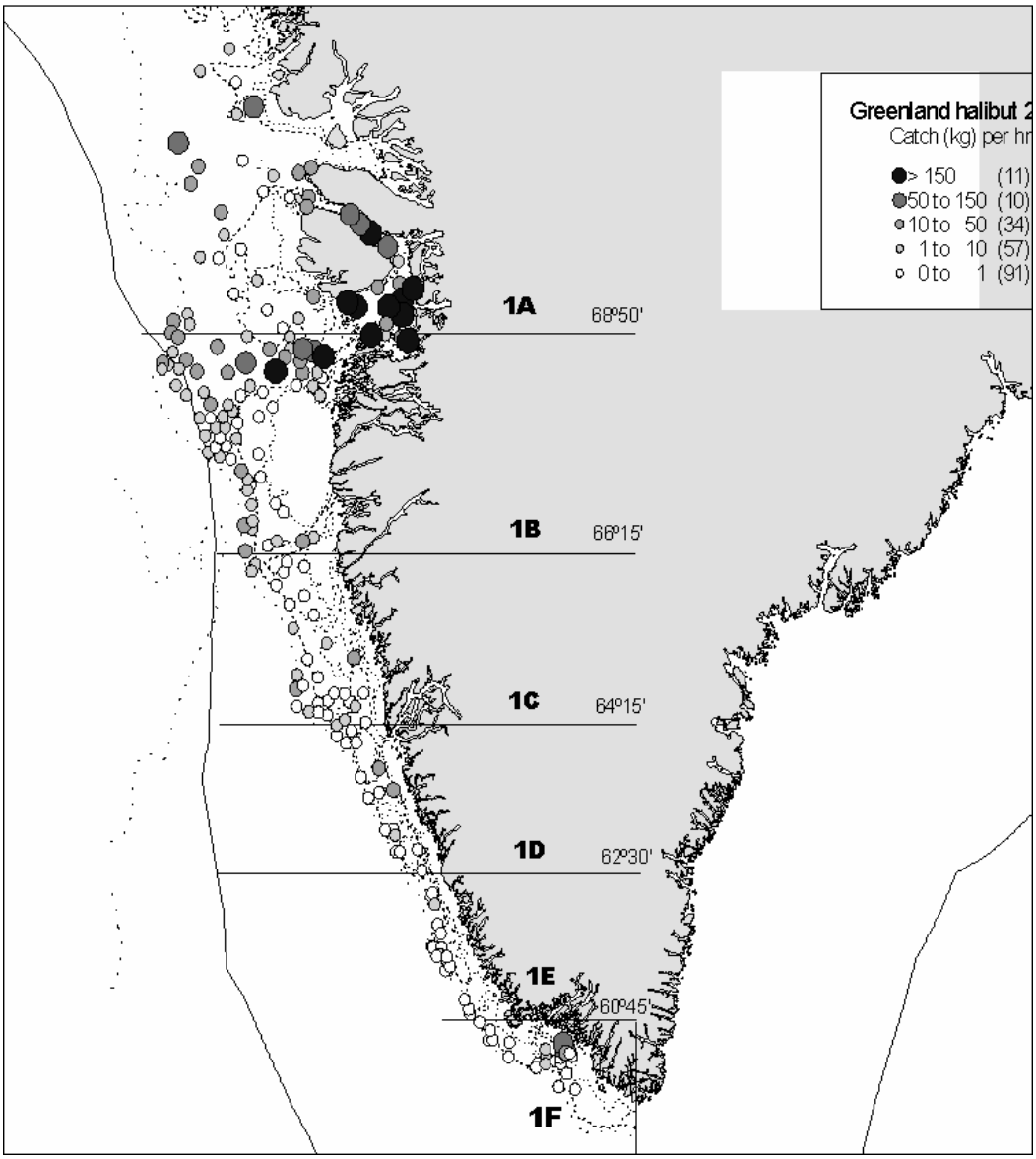

Fig. 2. Distribution of 2003-survey catches (kg/hour) of Greenland halibut (all hauls). The midline against Canada and the 200, 400 and 600 m depth contour lines are shown

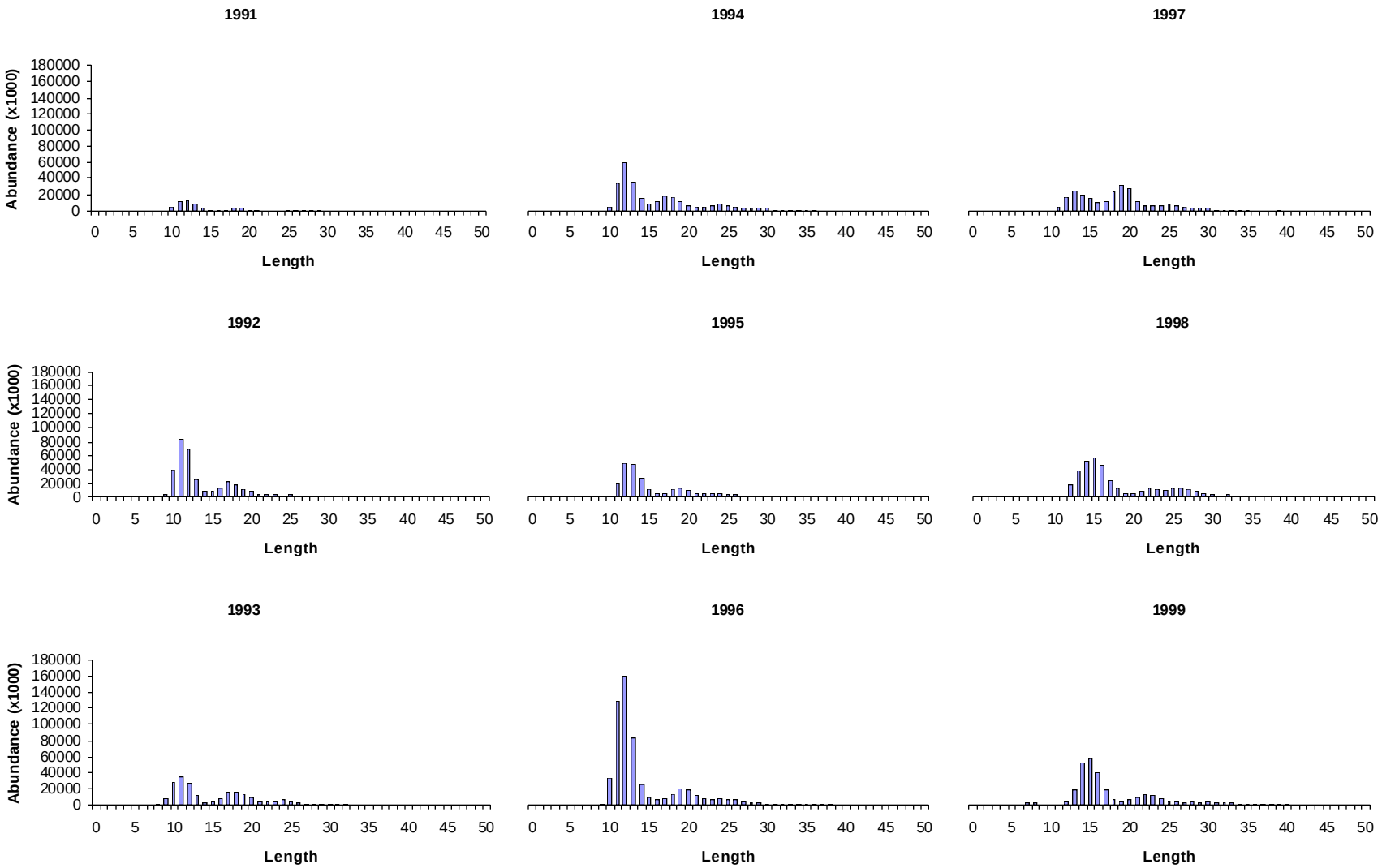

Fig. 3. Greenland halibut (*Reinhardtius hippoglossoides*). Length frequencies for West Greenland, 1991-1999.

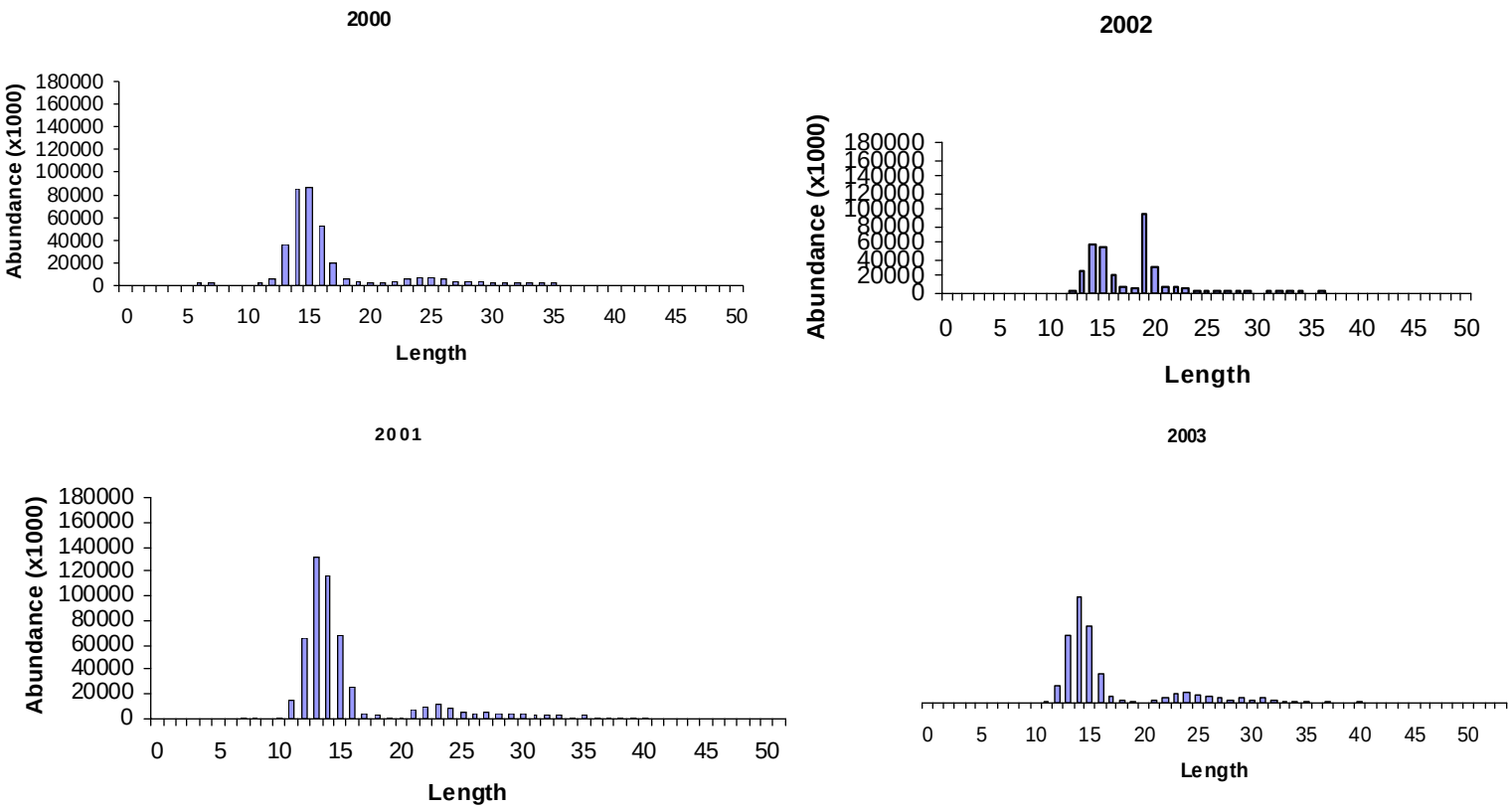

Fig. 3 cont. Greenland halibut (*Reinhardtius hippoglossoides)*. Length frequencies for West Greenland, 2000-2003.

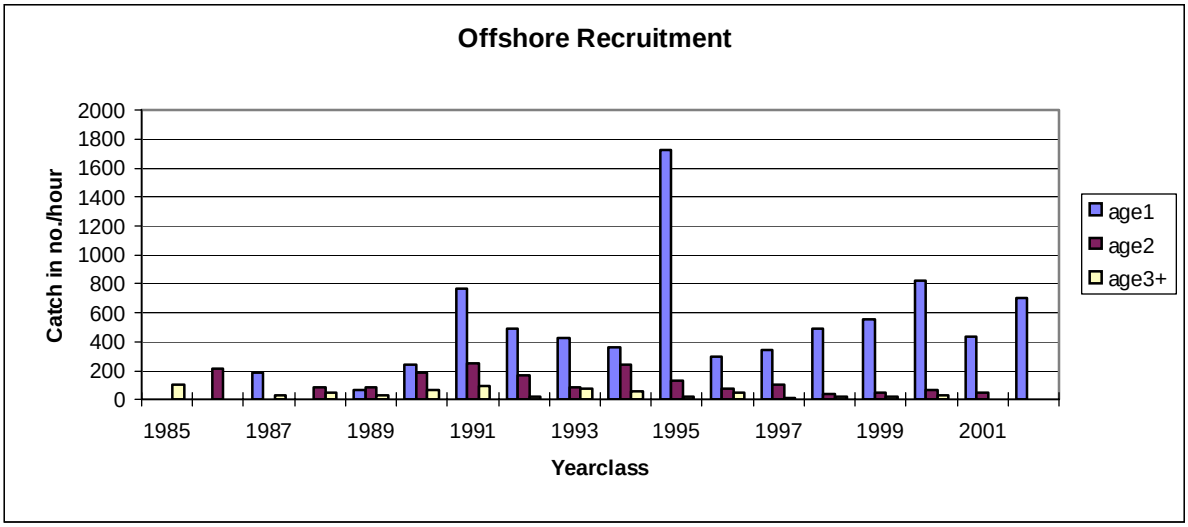

Fig. 4. Catch in number per hour of Greenland halibut at age 1, 2 and 3+ in the offshore nursery area (1AS-1B).

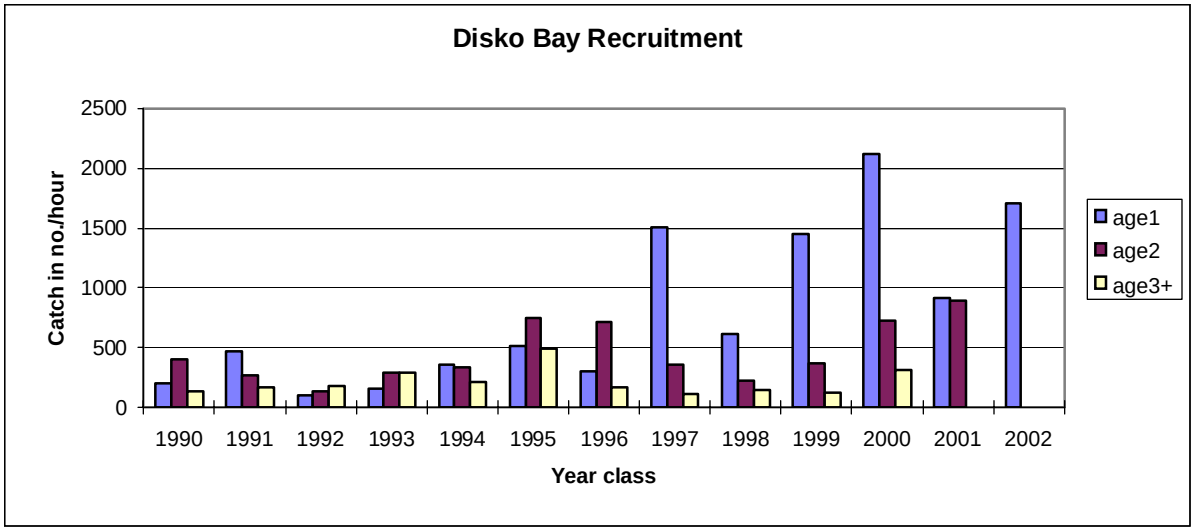

Fig. 4 cont. Catch in number per hour of Greenland halibut at age 1, 2 and 3+ in the in the inshore Disko Bay.

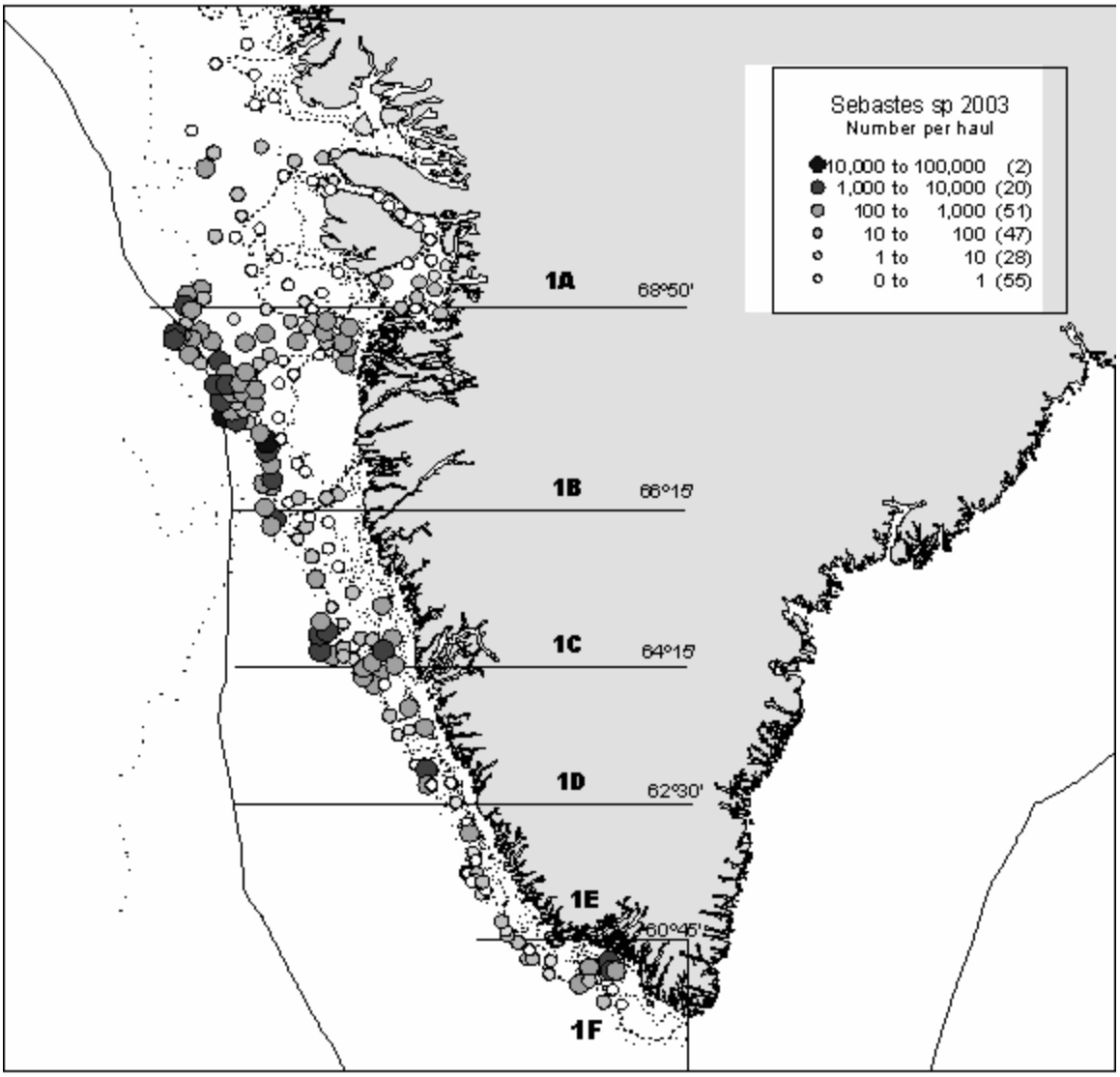

Fig. 5. Distribution of 2003-survey catches (number/hour) of redfish sp. (all hauls). The midline against Canada and the 200, 400 and 600 m depth contour lines are shown.

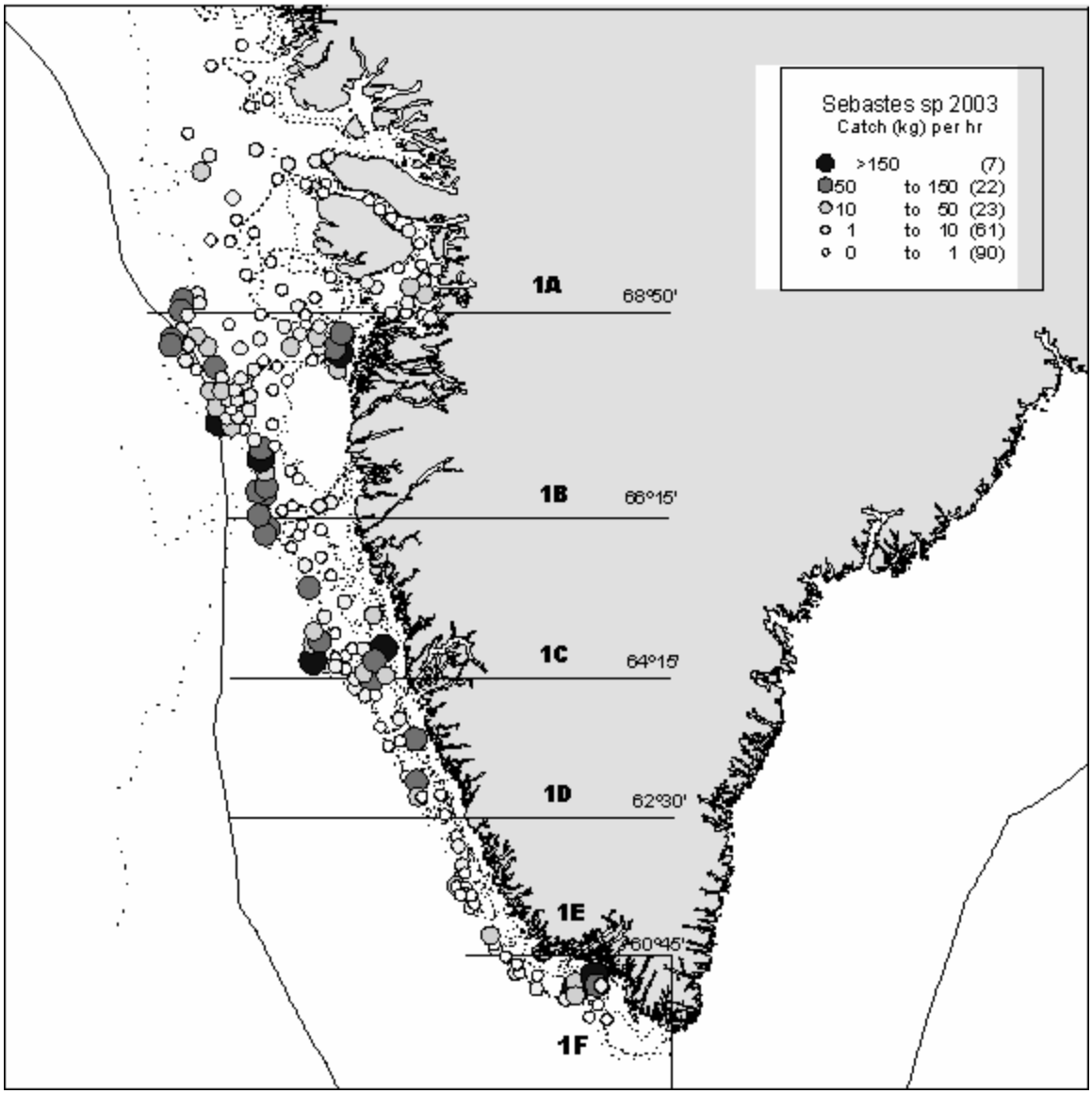

Fig. 6. Distribution of 2003-survey catches (kg/hour) of redfish sp. (all hauls). The midline against Canada and the 200, 400 and 600 m depth contour lines are shown.

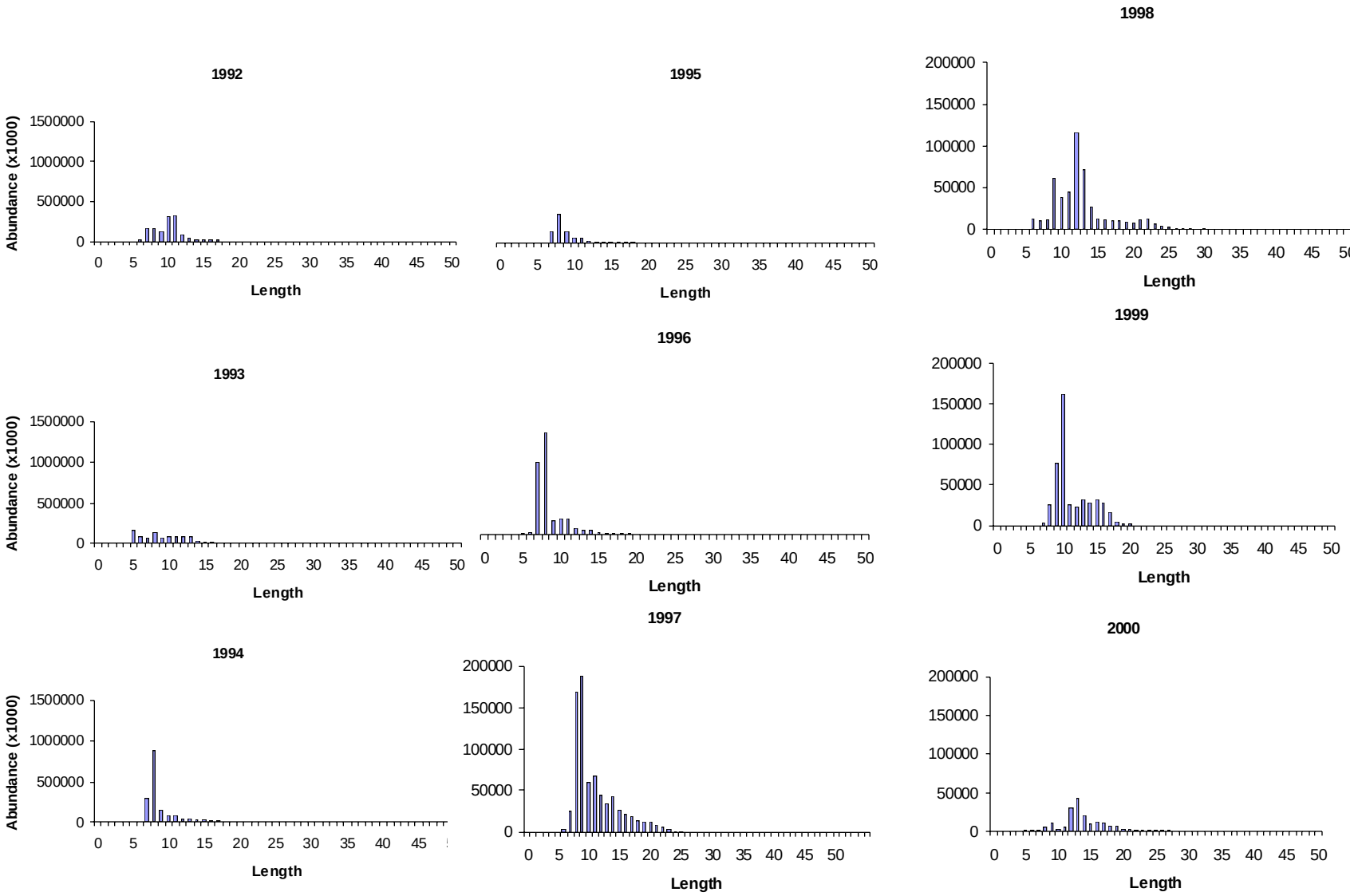

Fig. 7. Redfish (*Sebastes sp.*). Length frequencies for West Greenland, 1992-2000. From 1997 the scale has changed.

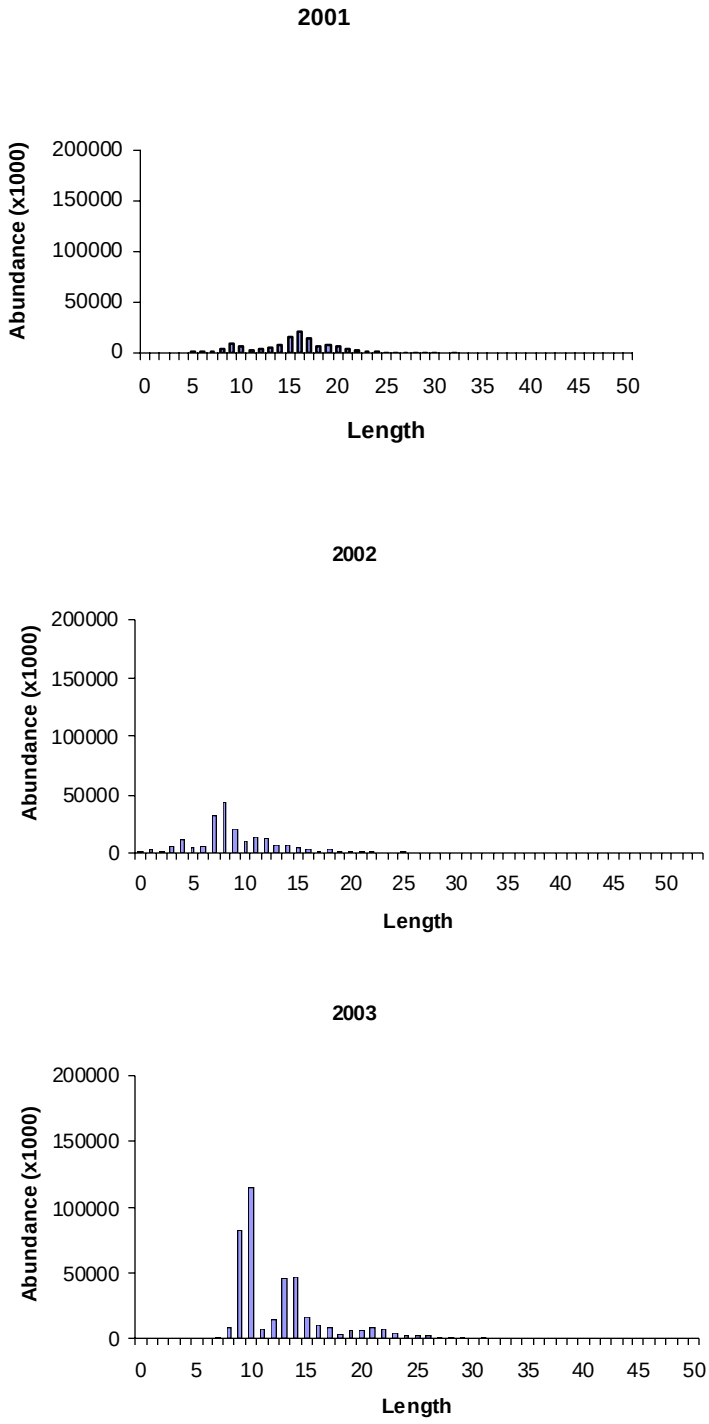

Fig. 7 cont. Redfish (*Sebastes sp.*). Length frequencies for West Greenland, 2001-2003. Notice that the scale has changed compared to the years 1992-1996.

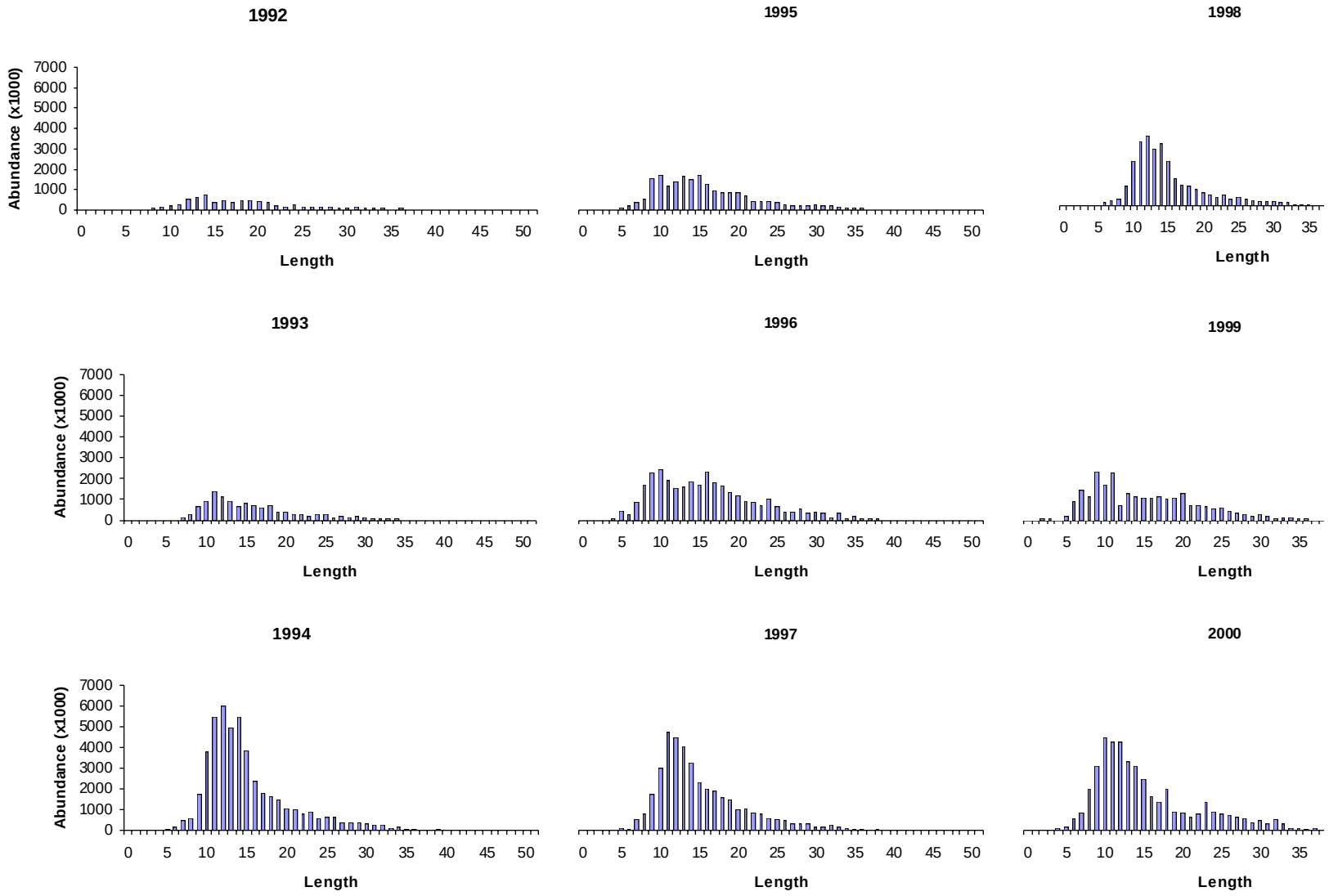

Fig. 8. American place (*Hippoglossoides platessoides*). Length frequencies, 1992-2000.

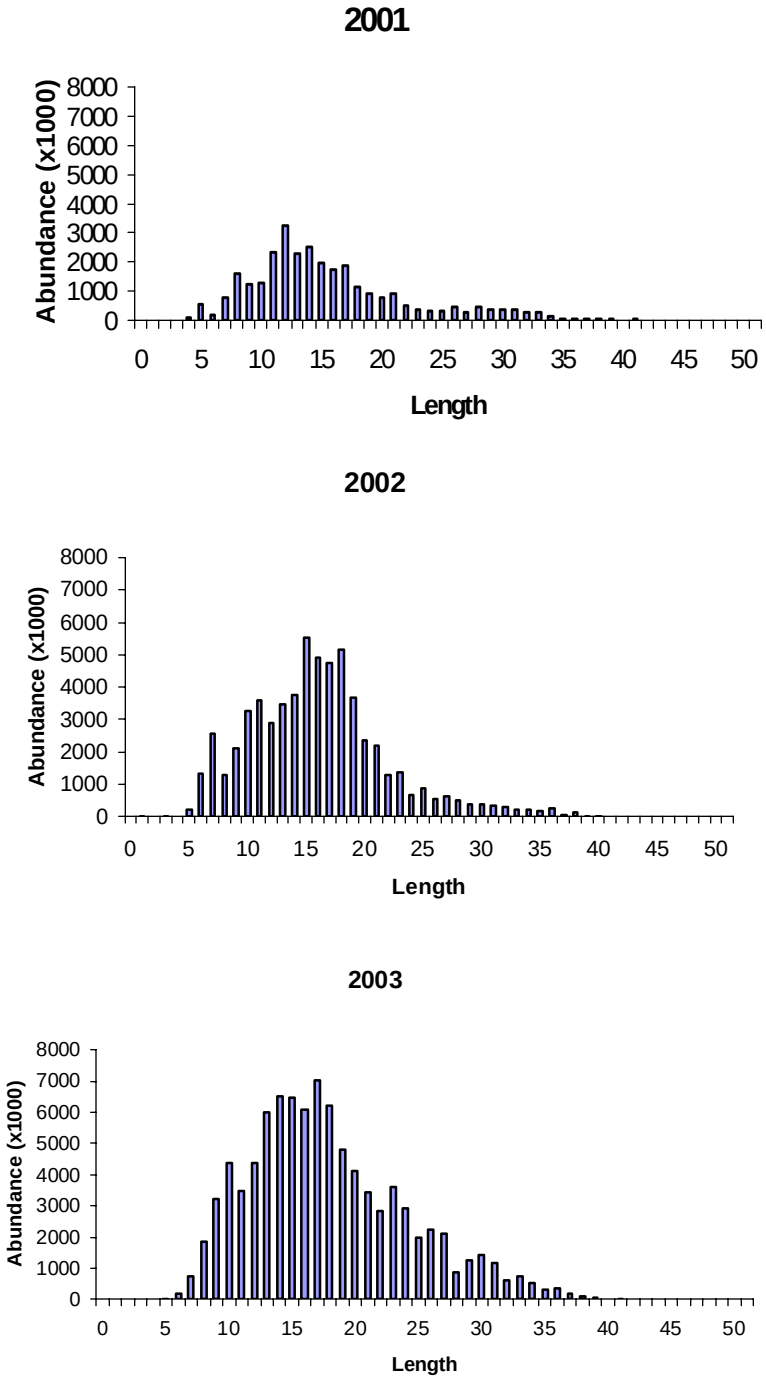

Fig. 8 cont. American place (*Hippoglossoides platessoides*). Length frequencies, 2001-2003.

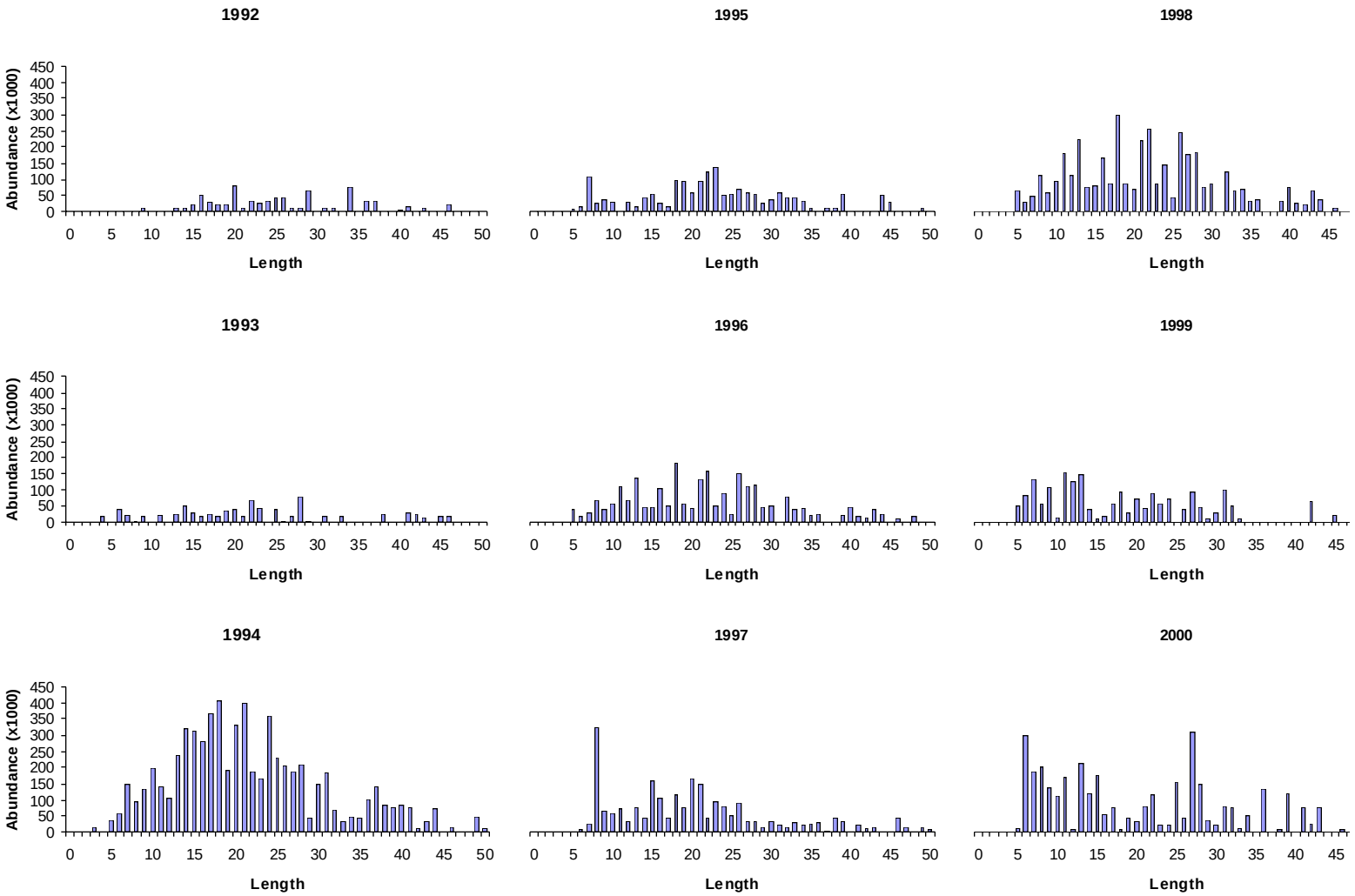

Fig. 9. Atlantic wolfish (*Anarhichas lupus*). Length frequencies for West Greenland 1992-2000.

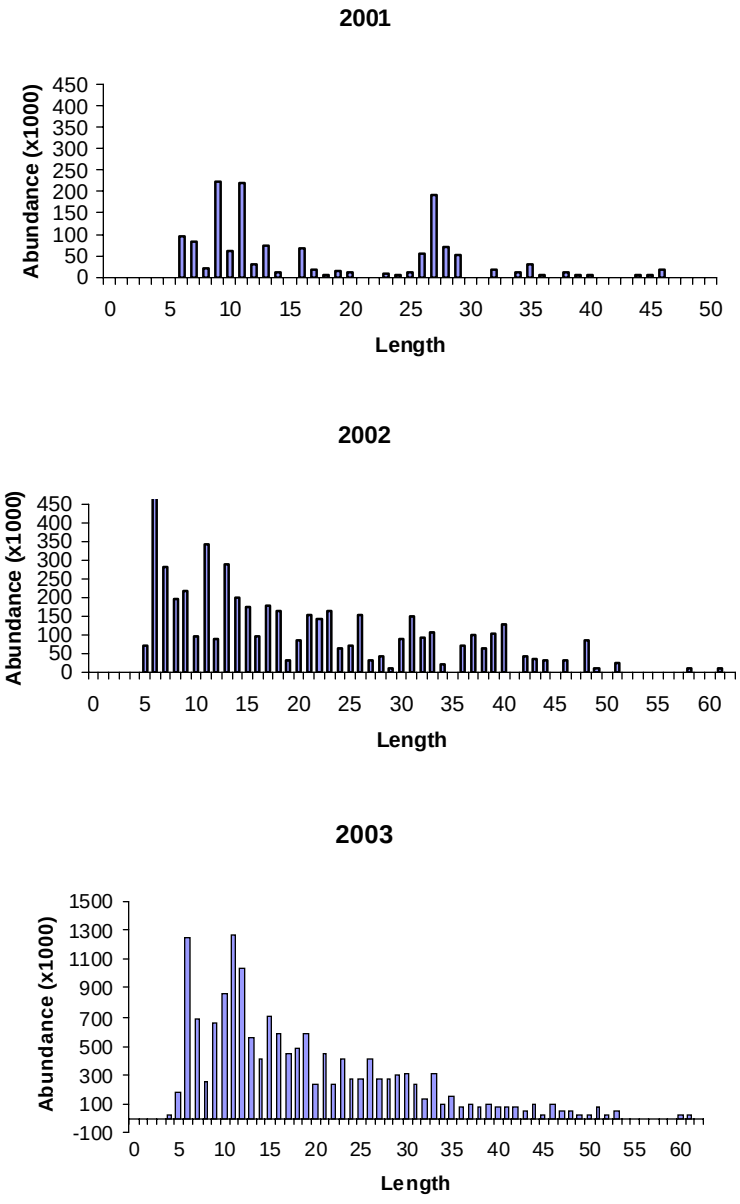

Fig. 9 cont. Atlantic wolfish (*Anarhichas lupus*). Length frequencies for West Greenland 2001-2003. Notice the scale has changed in 2003.

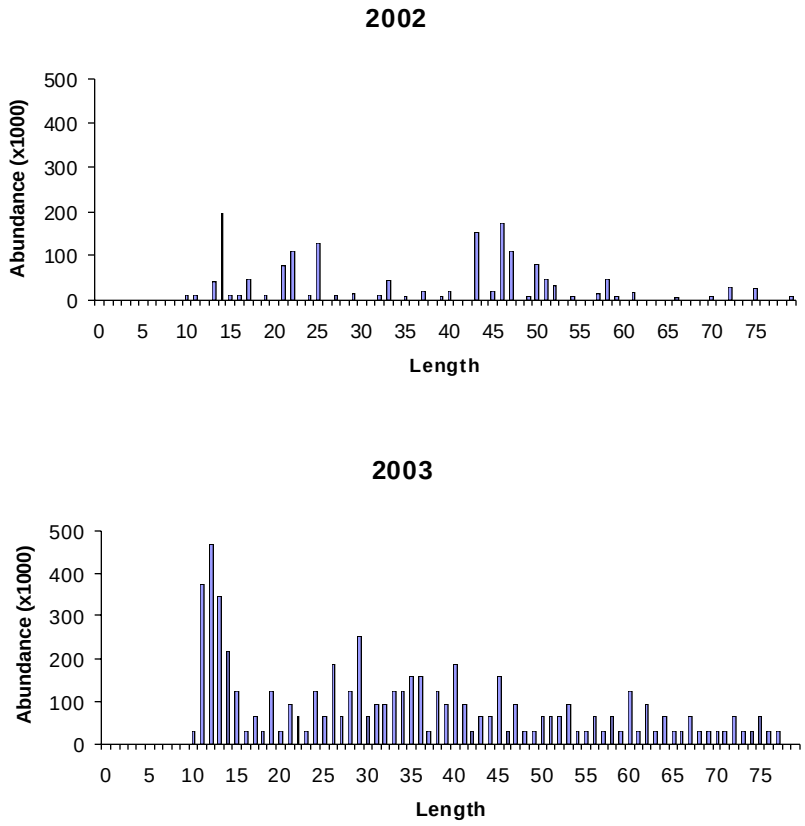

Fig. 10. Spotted wolffish (*Anarhichas minor*). Length frequencies for West Greenland 2002-2003. Length frequencies before 2002 are excluded due to very few observations.

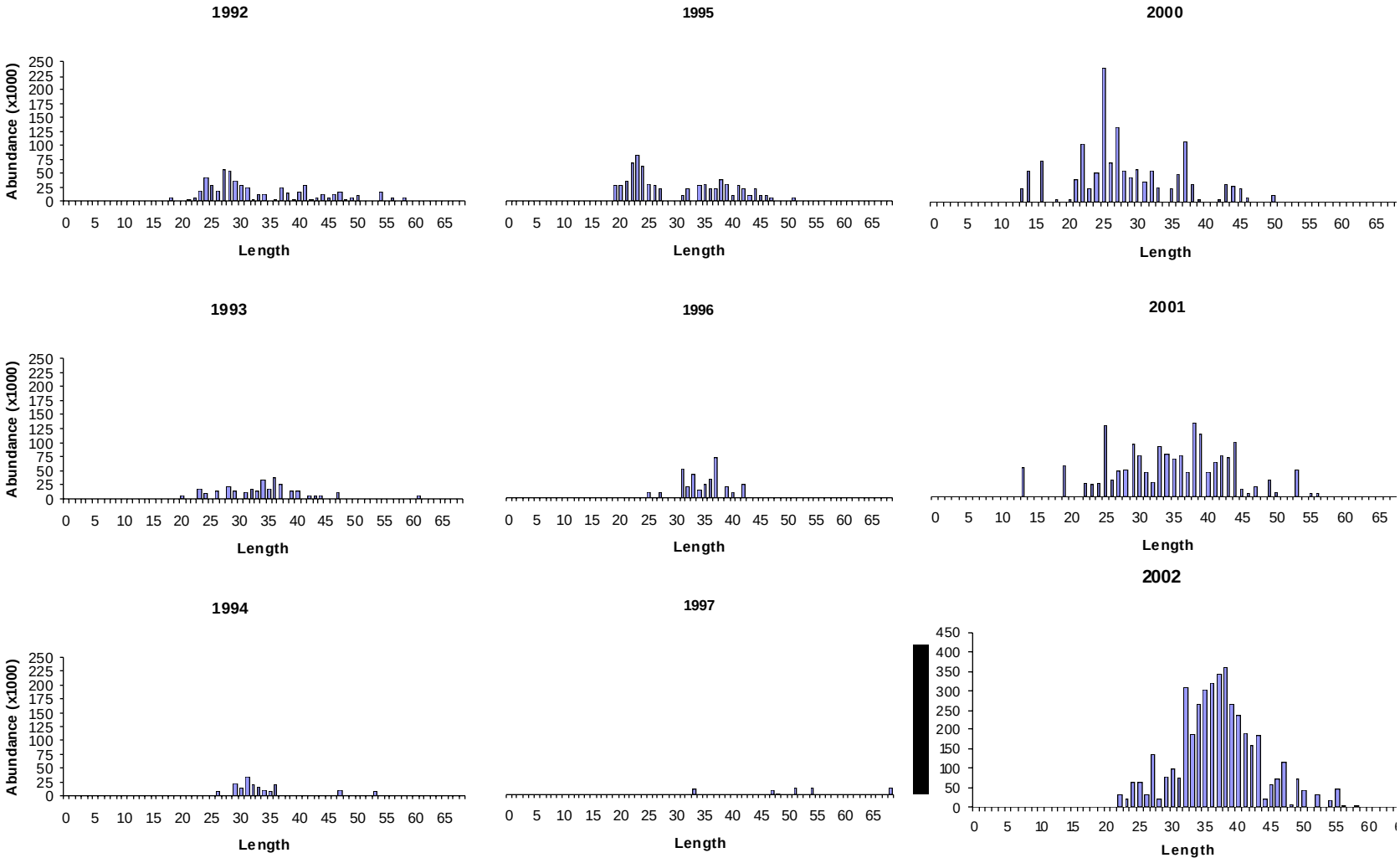

Fig. 11. Atlantic cod (*Gadus morhua*). Length frequencies for West Greenland 1992-2002. Notice the changed scale in 2002. 1998 and is 1999 excluded due to very few observations.

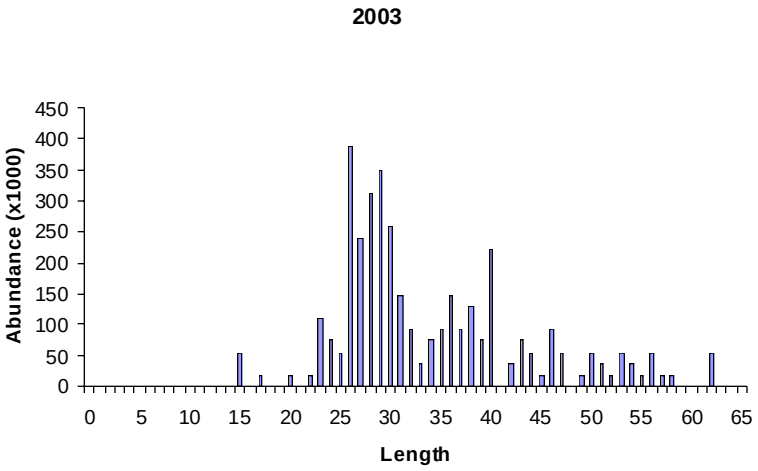

Fig. 11 cont. Atlantic cod (*Gadus morhua*). Length frequencies for West Greenland 2003.