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Transformed Results for Greenland Halibut from the Surveys Conducted by Spain in the NAFO Regulatory Area of Divisions 3NO, 1996-2002

by

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Abstract

Since 1995, a stratified random spring bottom trawl survey in the NAFO Regulatory Area of Div. 3NO was conducted by Spain. The depth strata surveyed was extended to 1464 m. The main propose of the surveys was obtain abundance and biomass indices and population structure for the commercial species in the area. In 2001, the trawl vessel was replaced in the realization of the trawls; so, the time series indices was transformed. The transformed entire series of abundance, biomass and length distribution for Greenland halibut are presented for the period 1996-2000, and the no-transformed data for the years 2001 and 2002. The standard deviation are shown for abundance and biomass. A decreasing in Greenland halibut biomass is observed in last years. A high percent of juvenile individuals shows a good recruitment in recent years.

Material and methods

Survey design and gear used

The surveys on NAFO Regulatory Area of Div. 3NO was initiated by Spain in 1995. Until 2001, the surveys was carried out in spring (May), on board the Spanish vessel *C/V Playa de Menduiña* (338 GT and 800 HP) using bottom trawl net type *Pedreira*. Since that year, the *R/V Vizconde de Eza* replaced the *C/V Playa de Menduíña* as the research vessel for the trawl, using bottom trawl net type *Campelen*. The main specifications and geometry of these gears, as the rigging profile and the net plan, and a sheet with the resume of the main technical data of the survey are described in previous paper (Walsh *et. al.*, 2001). In the table 1 are presented the number of valid tows, the depth strata covered and the dates of the survey series. In the period 1998-2002, the surveyed depth strata was the same (extended to 1464 m). The survey area was stratified following the standard stratification schemes (Bishop, 1994). Sets was allocated to strata proportionally to their size, with a minimum of two planned hauls per stratum and the trawl positions were chosen at random (Doubleday, 1981).
Biomass and abundance indices were calculated by the swept area method (Cochran, 1997), assuming catchability factor of 1.

The catch from each haul was sorted by species and weighed. Samples of Greenland halibut were measured at random to the total length at cm below**.** Length distribution estimated from catches is presented for the period 1996-2002. The year 1995 is not representative for this species, because in that year more deeper strata were not surveyed, so it is not included in the analysis.

R/V *Vizconde de Eza* had replaced C/V *Playa de Menduíña* in May 2001, so, in order to maintain the data series obtained since 1995, comparative fishing trials were conducted in May 2001 to develop factors between the two fishing gear combinations. A series of 92 paired hauls was carried out, 90 of then were valid hauls. Mean catch, stratified mean catch, abundance, biomass and their respective standard deviations, and length distribution, were transformed from C/V *Playa de Menduíña* series to R/V *Vizconde de Eza* series.

Greenland halibut stratified mean catches and SD

The mean catch ($\overline{y}_i$) and the variance (Var_i) are calculated by stratum by the following formulas:

$$\overline{y}_i = \sum_{j=1}^{T_i} \frac{y_j}{T_i}, \quad i = 1,...,h$$

$$Var_i = \sum_{j=1}^{T_i} \frac{(y_j - \overline{y}_i)^2}{T_i - 1}, \quad i = 1,...,h$$

where:

y_j is the catch in haul j in the stratum

T_i is the number of hauls in the stratum i

h is the total number of strata

and the stratified mean catch ($\overline{y}_i^{str}$) and the stratified variance (Var_i^{str}) by stratum are obtained as follow:

$$\overline{y}_i^{str} = \overline{y}_i n_i, \quad i = 1,...,h$$

$$Var_i^{str} = Var_i \frac{n_i^2}{T_i}, \quad i = 1,...,h$$

where:

n_i is the area of the stratum i, $i = 1,...,h$

Then the total stratified mean catch ($\overline{y}$) and the variance (Var) by year are calculated according to the formulas:

$$\overline{y} = \sum_{i=1}^{h} \frac{\overline{y}_i^{str}}{N}$$

$$Var = \sum_{i=1}^{h} \frac{Var_i^{str}}{N^2}$$

where:

$N = \sum_{i=1}^{h} n_i$ is the total area by year

The stratified standard deviation (SD) by year is calculated as the square root of the stratified variance by year.

Conversion factors

To convert data series it was necessary to calculated the factor power correction (FPC), typically estimated by use of catch per unit of effort (CPUE) observations for the two vessels. In this case, we obtained a estimated FPC as the ratio of sum of CPUE, in this way:

$$FPC = \frac{\sum Campelen\ catches}{\sum Pedreira\ catches} \quad (1)$$

This method has minor error than other methods used to convert CPUE data. Besides this, we had a large number of paired hauls without Greenland halibut catches, so in other models appeared problems in the fit. (Wilderbuer *et al.*, 1998, González Troncoso and Paz, 2003)

It was apply to convert mean catches, abundance and biomass. To convert abundance, we use the ratio of sum of abundance of each vessel.

In the other hand, to convert the length distribution, the following multiplicative model, proposed by Warren (1997) was adjusted:

$$Ratio = \alpha l^{\beta} e^{\delta l}$$

where:

$$Ratio = \frac{Campelen\ Catch}{Pedreira\ Catch} \text{ by length} \quad (2)$$

l is the length

$\alpha, \beta\ and\ \delta$ are the estimated parameters.

A logarithmic transformation was made to this model in order to adjust a linear expression.

For more details, see Paz *et al.* (2002).

Data series

For 1996-2000, transformed C/V *Playa de Menduíña* data series are presented. For 2002, original R/V *Vizconde de Eza* data series are presented. In 2001, the deeper strata was not surveyed by the calibration experience. As the objective is to have data in all the strata surveyed last years, to obtained the more annual homogeneity possible in the series, in the no surveyed strata by the R/V *Vizconde de Eza* the transformed C/V *Playa de Menduíña* data are put. This was made to mean catch, stratified mean catch, abundance and biomass. In this way, in the strata surveyed the original R/V *Vizconde de Eza* data are presented and in the strata not surveyed the transformed C/V *Playa de Menduíña* are offered.

Results

Greenland halibut Catches

To convert mean catches, we calculated the equation (1), giving the FPC_{bio} =0.09282661.

The Greenland halibut mean catches by stratum are presented in table 2, included swept area, number of hauls and SD. Greenland halibut stratified mean catches and its SD are presented in table 3. The Greenland halibut indices show an increasing until 1999, and a decreasing in the last three years (Figure 1), particularly in 2002. This great decreasing may be due to a change in the species distribution, to an increasing on exploitation rate, or both.

Greenland halibut Abundance and Biomass

To convert biomass, we calculated the equation (1), giving the $\overline{FPC}_{bio}$ =0.09282661. To adjust the abundance, we also calculated the equation (1), now for sum of abundance per unit of effort,, obtained $\overline{FPC}_{ab}$ =0.10587360.

Following the recommendations of the 2000 Scientific Council Meeting, the entire time series (1996-2002) of abundance and biomass and their SD estimates of Greenland halibut are presented (updated) in table 4 and table 5, respectively. In 2001, there is a presence of two strong length year classes, that appears in Figure 2 and Figure 5 with classes length mode of 13 cm. and 23 cm. This presence produces an increasing in the total abundance estimation. In the other hand, the biomass has the same trend than stratified mean catches.

Greenland halibut Length Distribution

The result of model (2) to Greenland halibut was the following:

$$\text{Ln(Ratio)} = \exp(14.5849-5.775\ln(l)+0.0816\,l)$$

Figure 4 shows the ratios and their fit. In this figure, in the case of data bellow 20 cm., we observed that the fit is very poor, so another conversion factor is applied for this values. Also, in lengths between 10-14, the fit results scattered. So three length class are formed as follow (cf = conversion factor):

For $l \le 14$: cf = 3.032
For $15 \le l \le 20$: cf = 0.792
For $21 \le l$: cf = $\exp(14.5849-5.775\ln(l)+0.0816\,l)$

In table 6 is shown Greenland halibut length distribution per thousand, besides the sampled size and its catch for the period 1996-2002. In figure 5 we can see the length distribution evolution along the years. We can see a great presence of juveniles along the years, so we can expect an increasing in biomass next years.

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TABLE 1.- Spanish spring bottom trawl surveys on NAFO Div. 3NO: 1996-2002

Year	Vessel	Valid tows	Depth strata covered (m)	Dates
1996	C/V Playa de Menduíña	112	>56-1098	May 07-May 24
1997	C/V Playa de Menduíña	128	>56-1280	April 26-May 18
1998	C/V Playa de Menduíña	124	>56-1464	May 06-May 26
1999	C/V Playa de Menduíña	114	>56-1464	May 07-May 26
2000	C/V Playa de Menduíña	118	>56-1464	May 07-May 28
2001	R/V Vizconde de Eza	83	>56-1116	May 05-May 23
2002	R/V Vizconde de Eza	125	>56-1464	April 29-May 19

TABLE 2.- Swept area, number of hauls and Greenland halibut mean catch (Kg) and SD (**) by stratum. Spanish Spring Survey on NAFO Div. 3NO: 1996-2002.
Swept area in square miles. n.s. means stratum not surveyed. 1996-2000 data are transformed C/V *Playa de Menduíña* data, and 2001-2002 data are original from R/V *Vizconde de Eza*.
In 2001, (*) indicates transformed data from C/V *Playa de Menduíña*.

	1996				1997				1998				1999			
Stratum	Swept area	Tow number	G. halibut Mean catch	G. halibut SD	Swept area	Tow number	G. halibut Mean catch	G. halibut SD	Swept area	Tow number	G. halibut Mean catch	G. halibut SD	Swept area	Tow number	G. halibut Mean catch	G. halibut SD
353	0.0371	3	0.20	0.236	0.0480	4	0.06	0.053	0.0465	4	1.37	1.274	0.0360	3	0.61	0.569
354	0.0319	3	1.24	0.729	0.0233	2	0.70	0.095	0.0356	3	2.36	1.246	0.0218	2	0.86	0.781
355	0.0221	2	5.60	0.466	0.0233	2	4.07	0.230	0.0221	2	0.29	0.066	0.0229	2	0.22	0.295
356	0.0203	2	1.46	1.076	0.0225	2	4.11	1.871	0.0221	2	4.27	4.759	0.0229	2	0.23	0.174
357	0.0218	2	4.50	5.195	0.0443	4	1.08	1.341	0.0240	2	8.40	6.433	0.0236	2	1.69	0.276
358	0.0319	3	3.36	3.463	0.0563	5	1.38	1.168	0.0236	3	2.35	1.843	0.0349	3	4.10	3.155
359	0.0548	5	0.40	0.354	0.0690	6	0.66	0.623	0.0698	6	0.22	0.185	0.0364	3	2.15	3.725
360	0.3761	31	0.01	0.044	0.3754	32	0.04	0.183	0.2561	25	0.04	0.158	0.2325	19	0.31	0.918
374	0.0233	2	0.00	0.000	0.0353	3	0.00	0.000	0.0353	3	0.05	0.080	0.0244	2	0.00	0.000
375	0.0229	2	0.00	0.000	0.0116	1	0.00	-	0.0345	3	0.00	0.000	0.0236	2	0.00	0.000
376	0.1650	14	0.00	0.000	0.1583	14	0.00	0.000	0.0930	10	0.00	0.000	0.1219	10	0.00	0.000
377	0.0229	2	1.33	1.231	0.0116	1	0.00	-	0.0229	2	0.03	0.039	0.0240	2	0.48	0.683
378	0.0330	3	1.60	1.180	0.0210	2	0.78	0.985	0.0120	2	0.66	0.873	0.0229	2	1.03	0.330
379	0.0113	1	5.22	-	0.0206	2	2.23	1.031	0.0356	3	1.88	0.826	0.0236	2	0.96	0.013
380	0.0221	2	3.45	1.004	0.0210	2	2.64	1.210	0.0113	2	2.48	2.022	0.0236	2	3.94	1.326
381	0.0229	2	4.85	3.354	0.0221	2	0.21	0.009	0.0229	2	0.70	0.144	0.0229	2	2.82	0.985
382	0.0338	3	0.77	1.175	0.0461	4	0.00	0.000	0.0229	3	0.04	0.064	0.0484	4	0.00	0.001
721	0.0214	2	1.62	0.039	0.0221	2	2.98	1.053	0.0203	2	11.82	9.833	0.0244	2	0.62	0.249
722	0.0206	2	3.09	3.338	0.0214	2	1.53	2.163	0.0101	2	24.84	1.628	0.0229	2	13.36	7.909
723	0.0109	1	3.60	-	0.0210	2	5.16	2.543	0.0233	2	5.32	1.956	0.0229	2	11.07	10.916
724	0.0203	2	2.44	1.083	0.0225	2	1.92	0.624	0.0206	2	8.40	1.044	0.0225	2	4.55	1.181
725	0.0225	2	1.35	0.236	0.0206	2	7.85	4.225	0.0086	1	2.07	-	0.0229	2	4.97	5.763
726	0.0218	2	1.52	0.292	n.s.	n.s.	n.s.	n.s.	0.0094	2	27.96	33.187	0.0225	2	29.04	26.314
727	0.0210	2	4.06	1.871	0.0094	1	5.16	-	0.0233	2	7.80	6.754	0.0236	2	10.48	8.316
728	0.0218	2	18.02	4.936	0.0214	2	36.24	23.055	0.0206	2	57.21	56.042	0.0233	2	62.32	12.655
752	0.0109	1	15.84	-	0.0218	2	36.90	9.964	0.0229	2	54.22	23.669	0.0233	2	56.93	8.677
753	0.0199	2	23.32	6.413	0.0214	2	32.43	8.270	0.0218	2	33.32	8.507	0.0229	2	64.23	4.417
754	n.s.	n.s.	n.s.	n.s.	0.0330	3	18.70	4.941	0.0210	2	17.32	4.706	0.0206	2	17.12	11.204
755	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	0.0206	2	19.07	0.177	0.0311	3	15.94	8.279
756	0.0210	2	29.43	17.722	0.0109	1	68.36	-	0.0225	2	220.13	34.559	0.0225	2	125.28	46.721
757	0.0188	2	47.78	56.915	0.0304	3	34.70	10.823	0.0206	2	95.25	21.628	0.0233	2	106.53	27.496
758	n.s.	n.s.	n.s.	n.s.	0.0214	2	39.36	23.502	0.0105	2	52.55	9.813	0.0214	2	52.72	11.736
759	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	0.0214	2	48.19	35.497	0.0218	2	44.72	44.096
760	0.0210	2	12.15	4.266	0.0105	1	10.44	-	0.0214	2	32.89	28.743	0.0225	2	44.98	46.019
761	0.0199	2	30.20	12.051	0.0315	3	61.90	36.985	0.0206	2	46.01	16.364	0.0210	2	37.88	1.004
762	n.s.	n.s.	n.s.	n.s.	0.0308	3	45.89	27.172	0.0094	2	38.22	15.038	0.0210	2	63.34	37.289
763	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	0.0218	2	35.02	27.312	0.0311	3	21.44	8.946
764	0.0210	2	22.10	3.748	0.0206	2	20.63	2.422	0.0218	2	21.31	10.686	0.0225	2	28.81	12.412
765	0.0199	2	17.44	5.048	0.0206	2	35.43	14.289	0.0098	2	22.82	3.131	0.0221	2	31.43	0.328
766	n.s.	n.s.	n.s.	n.s.	0.0308	3	62.87	9.784	0.0191	2	20.82	3.479	0.0218	2	31.31	20.000
767	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	0.0109	2	10.21	50.629	0.0214	2	25.90	9.786

$$(**)\ SD = \frac{\sum (x_i - \bar{x})}{n-1}$$

TABLE 2 (cont.).- Swept area, number of hauls and Greenland halibut mean catch (Kg) and SD (**) by stratum. Spanish Spring Survey on NAFO Div. 3NO: 1996-2002.

Swept area in square miles. n.s. means stratum not surveyed. 1996-2000 data are transformed C/V *Playa de Menduíña* data, and 2001-2002 data are original from *R/V Vizconde de Eza*. In 2001, (*) indicates transformed data from C/V *Playa de Menduíña*.

Stratum	2000				2001				2002			
	Swept area	Tow number	G. halibut Mean catch	G. halibut SD	Swept area	Tow number	G. halibut Mean catch	G. halibut SD	Swept area	Tow number	G. halibut Mean catch	G. halibut SD
353	0.0356	3	0.19	0.178	0.0341	3	0.03	0.038	0.0476	4	0.21	0.278
354	0.0356	3	0.11	0.057	0.0338	3	3.22	1.927	0.0356	3	0.85	0.839
355	0.0233	2	0.22	0.274	0.0240	2	17.25	15.486	0.0236	2	0.43	0.467
356	0.0225	2	0.49	0.043	0.0240	2	0.07	0.042	0.0233	2	1.40	1.131
357	0.0124	1	0.11	-	0.0244	2	2.69	2.135	0.0240	2	1.15	1.626
358	0.0341	3	0.48	0.529	0.0345	3	8.46	12.298	0.0345	3	3.20	0.819
359	0.0469	4	1.35	2.014	0.0803	7	1.97	2.329	0.0686	6	0.28	0.219
360	0.2396	20	0.13	0.352	0.2423	20	0.17	0.484	0.2865	25	0.00	0.007
374	0.0240	2	0.00	0.000	0.0240	2	0.00	0.000	0.0345	3	0.00	0.000
375	0.0244	2	0.00	0.000	0.0338	3	0.00	0.000	0.0353	3	0.00	0.000
376	0.1200	10	0.00	0.000	0.1155	10	0.00	0.000	0.1140	10	0.00	0.000
377	0.0229	2	0.16	0.221	0.0229	2	0.42	0.537	0.0229	2	0.00	0.001
378	0.0233	2	1.09	1.214	0.0236	2	5.69	8.040	0.0233	2	1.85	0.636
379	0.0225	2	1.23	0.880	0.0229	2	4.61	4.236	0.0229	2	5.85	4.313
380	0.0236	2	2.42	1.447	0.0206	2	4.06 (*)	0.066 (*)	0.0225	2	5.05	3.041
381	0.0236	2	1.36	0.352	0.0236	2	0.90 (*)	1.271 (*)	0.0229	2	0.53	0.145
382	0.0499	4	0.12	0.147	0.0469	4	0.05 (*)	0.080 (*)	0.0341	3	0.40	0.683
721	0.0236	2	0.48	0.681	0.0248	2	0.40	0.431	0.0233	2	0.08	0.062
722	0.0218	2	19.49	9.977	0.0233	2	1.09	0.863	0.0236	2	2.63	2.906
723	0.0248	2	2.85	1.094	0.0240	2	1.33	0.240	0.0233	2	1.24	1.075
724	0.0233	2	5.83	2.179	0.0353	3	3.45	2.786	0.0225	2	4.75	1.202
725	0.0210	2	10.03	8.796	0.0116	1	3.04	-	0.0225	2	7.35	6.718
726	0.0221	2	12.95	3.348	0.0116	1	4.50	-	0.0214	2	3.25	3.323
727	0.0210	2	2.65	1.181	0.0225	2	3.79 (*)	0.243 (*)	0.0233	2	2.01	1.400
728	0.0210	2	29.91	0.098	0.0229	2	8.62 (*)	1.654 (*)	0.0229	2	7.93	10.986
752	0.0206	2	23.33	1.989	0.0210	2	26.37 (*)	8.723 (*)	0.0116	1	0.34	-
753	0.0218	2	49.77	21.700	0.0214	2	22.66 (*)	4.883 (*)	0.0229	2	2.45	3.465
754	0.0195	2	46.69	14.381	0.0195	2	41.09 (*)	41.477 (*)	0.0341	3	20.33	4.996
755	0.0431	4	35.73	20.076	0.0416	4	27.16 (*)	16.279 (*)	0.0338	3	0.46	0.655
756	0.0203	2	60.60	40.187	0.0113	1	18.70	-	0.0229	2	10.55	14.920
757	0.0214	2	37.41	10.108	0.0233	2	42.23 (*)	4.326 (*)	0.0225	2	9.95	2.192
758	0.0210	2	56.67	11.487	0.0218	2	42.11 (*)	8.828 (*)	0.0225	2	17.15	1.485
759	0.0210	2	29.43	8.579	0.0221	2	76.11 (*)	21.890 (*)	0.0225	2	2.15	3.041
760	0.0210	2	30.56	2.862	0.0229	2	9.42	10.861	0.0229	2	4.75	4.172
761	0.0221	2	36.09	26.813	0.0225	2	8.10	7.778	0.0225	2	16.65	16.900
762	0.0203	2	36.37	1.726	0.0116	1	7.60	-	0.0225	2	2.11	1.563
763	0.0416	4	25.64	21.799	0.0330	3	31.61 (*)	22.554 (*)	0.0225	2	0.74	1.047
764	0.0218	2	16.96	6.498	0.0240	2	53.64	1.888	0.0236	2	6.95	5.869
765	0.0203	2	37.13	30.587	0.0113	1	26.60	-	0.0236	2	45.90	39.739
766	0.0214	2	16.76	2.475	0.0203	2	16.42 (*)	9.557 (*)	0.0233	2	9.53	1.025
767	0.0210	2	21.21	6.393	0.0218	2	5.72 (*)	2.593 (*)	0.0225	2	0.85	1.202

$$(**)\ SD = \frac{\sum (x_i - \bar{x})}{n-1}$$

TABLE 3.- Stratified mean catches (Kg) and SD of Greenland halibut by stratum and year (1996-2002). n.s. means stratum not surveyed. 1996-2000 data are transformed C/V *Playa de Menduíña* data. 2001-2002 data are original from R/V *Vizconde de Eza*. In 2001, (*) indicates transformed data from C/V *Playa de Menduíña*.

Strata	1996	1997	1998	1999	2000	2001	2002
353	54.10	15.61	368.31	164.80	50.27	7.17	57.16
354	0.01	171.84	581.54	211.23	27.55	792.94	209.92
355	0.08	301.21	21.29	16.18	16.14	1276.50	31.86
356	0.03	193.06	200.47	10.97	23.25	3.29	65.80
357	737.96	176.36	1377.73	277.07	17.81	441.16	188.60
358	755.38	310.53	529.11	921.77	108.61	1903.50	720.00
359	168.83	279.62	94.44	905.35	568.81	827.57	116.83
360	35.83	120.66	100.23	852.78	358.57	461.98	5.79
374	0.00	0.00	9.93	0.00	0.00	0.00	0.00
375	0.00	0.00	0.00	0.00	0.00	0.00	0.00
376	0.00	0.00	0.00	0.00	0.00	0.00	0.00
377	133.44	0.00	2.78	48.27	15.59	42.00	0.10
378	223.01	108.38	92.26	143.03	151.61	790.22	257.15
379	553.48	236.64	199.42	101.35	130.87	488.13	620.10
380	331.06	253.84	237.93	377.84	232.32	(*) 389.43	484.80
381	698.43	30.54	100.25	406.36	196.29	(*) 129.93	75.96
382	265.33	0.00	12.74	0.16	42.51	(*) 16.16	137.54
721	104.99	193.53	768.09	40.40	31.32	25.68	5.23
722	259.46	128.46	2086.59	1122.44	1637.46	91.56	220.50
723	558.26	799.62	824.44	1715.78	441.21	206.15	192.20
724	302.15	237.69	1041.12	564.01	722.86	427.80	589.00
725	141.33	824.43	217.35	521.45	1052.65	319.20	771.75
726	109.78	n.s.	2013.07	2090.94	932.35	324.00	234.00
727	389.87	495.47	749.00	1006.54	253.97	(*) 364.03	192.96
728	36.04	2826.86	4462.31	4861.26	2333.24	(*) 672.64	618.66
752	2074.54	4833.71	7102.82	7457.90	3056.49	(*) 3454.13	44.41
753	3218.53	4475.84	4597.53	8863.93	6868.76	(*) 3126.94	338.10
754	n.s.	3365.21	3117.02	3081.94	8403.69	(*) 7396.15	3660.00
755	n.s.	n.s.	7342.42	6136.26	13757.44	(*) 10457.90	177.23
756	2972.03	6904.11	22233.50	12653.16	6121.02	1888.70	1065.55
757	4873.81	3539.38	9715.91	10866.31	3815.73	(*) 4307.61	1014.90
758	n.s.	3896.21	5202.82	5218.91	5610.39	(*) 4168.97	1697.85
759	n.s.	n.s.	6119.66	5679.93	3737.70	(*) 9666.37	273.05
760	1871.25	1608.22	5065.54	6926.79	4706.01	1450.68	731.50
761	5163.60	10584.19	7867.63	6477.12	6170.76	1385.10	2847.15
762	n.s.	9728.04	8102.93	13428.13	7711.31	1611.20	446.26
763	n.s.	n.s.	9139.92	5595.80	6691.10	(*) 8250.35	193.14
764	2209.74	2063.07	2131.30	2880.87	1695.94	5363.50	695.00
765	2162.25	4392.98	2829.86	3897.46	4604.20	3298.40	5691.60
766	n.s.	9053.27	2998.23	4508.03	2413.42	(*) 2364.63	1371.60
767	n.s.	n.s.	1613.33	4092.64	3351.32	(*) 904.20	134.30
TOTAL	30404.58	72148.61	121270.85	124125.15	98060.56	79095.85	26177.55
$(\overline{Y})$	3.46	7.73	11.73	12.00	9.48	7.65	2.64
SD	0.54	0.62	0.89	1.00	0.75	0.76	0.45

TABLE 4.- Survey estimates (by the swept area method) of Greenland halibut abundance (,000) and SD by stratum and year on NAFO Div. 3NO. n.s. means stratum not surveyed. 1996-2000 data are transformed C/V *Playa de Menduíña* data. 2001-2002 data are original from R/V *Vizconde de Eza*. In 2001, (*) indicates transformed data from C/V *Playa de Menduíña*.

Strata	1996	1997	1998	1999	2000	2001	2002
353	0	9	187	47	16	24	170
354	212	95	268	101	23	1429	487
355	375	348	4	6	9	1893	31
356	46	149	75	4	4	2	58
357	469	93	653	84	3	116	61
358	1495	423	301	634	26	2984	615
359	94	183	53	331	146	1096	483
360	0	76	58	308	85	244	50
374	0	0	4	0	0	0	0
375	0	0	0	0	0	0	0
376	0	0	0	0	0	0	0
377	75	0	1	31	5	38	4
378	171	72	47	112	57	591	233
379	285	176	124	75	35	135	171
380	214	146	164	1048	122	(*) 274	610
381	401	14	45	269	66	(*) 33	200
382	98	0	6	1	8	(*) 5	251
721	89	132	379	7	6	3	11
722	99	67	573	207	213	14	39
723	264	407	369	433	82	45	92
724	145	94	361	125	85	78	126
725	93	444	157	183	258	63	143
726	75	n.s.	863	613	175	31	57
727	261	295	382	324	92	(*) 123	267
728	500	1296	2163	1445	571	(*) 127	280
752	497	1008	2136	1978	553	(*) 534	395
753	867	728	726	1782	1093	(*) 402	48
754	n.s.	347	309	419	880	(*) 834	197
755	n.s.	n.s.	881	788	1712	(*) 1095	11
756	780	1457	5558	3380	1256	323	234
757	991	515	1620	2639	518	(*) 569	154
758	n.s.	706	620	625	589	(*)366	242
759	n.s.	n.s.	837	1016	457	(*) 947	34
760	425	414	1061	1486	794	259	94
761	582	1067	1853	1005	744	167	387
762	n.s.	1036	1127	2818	819	74	75
763	n.s.	n.s.	967	613	724	(*) 717	12
764	411	428	354	597	204	713	80
765	1128	548	580	459	769	353	645
766	n.s.	1030	317	203	211	(*) 222	81
767	n.s.	n.s.	104	364	250	(*) 64	13
TOTAL	11143	13804	26286	26555	13658	16987	7142
SD	1903	1130	2497	2830	1225	3227	958

TABLE 5.- Survey estimates (by the swept area method) of Greenland halibut biomass (t) and SD by stratum and year on NAFO Div. 3NO. n.s. means stratum not surveyed. 1996-2000 data are transformed C/V *Playa de Menduíña* data. 2001-2002 data are original from R/V *Vizconde de Eza*. In 2001, (*) indicates transformed data from C/V *Playa de Menduíña*.

Strata	1996	1997	1998	1999	2000	2001	2002
353	4	1	32	14	4	1	5
354	29	15	49	19	2	70	18
355	37	26	2	1	1	106	3
356	7	17	18	1	2	0	6
357	68	16	115	23	1	37	16
358	71	28	46	79	10	164	63
359	15	24	8	75	49	73	10
360	3	10	9	70	30	41	1
374	0	0	1	0	0	0	0
375	0	0	0	0	0	0	0
376	0	0	0	0	0	0	0
377	12	0	0	4	1	4	0
378	20	10	8	13	13	66	22
379	49	23	17	9	12	43	54
380	30	24	21	32	20	(*) 38	43
381	61	3	9	36	17	(*) 11	7
382	24	0	1	0	3	(*) 1	12
721	10	17	76	3	3	2	0
722	25	12	195	98	151	8	19
723	51	76	71	150	36	17	17
724	30	21	101	50	62	37	52
725	13	80	25	46	100	27	69
726	10	n.s.	195	186	84	28	22
727	37	53	64	85	24	(*) 32	17
728	129	265	433	418	222	(*) 59	54
752	191	444	621	642	296	(*) 325	151
753	324	419	423	775	632	(*) 303	30
754	n.s.	306	297	299	862	(*) 680	275
755	n.s.	n.s.	712	591	1276	(*) 979	14
756	283	635	1976	1125	605	168	93
757	520	350	942	935	357	(*) 370	90
758	n.s.	365	478	488	534	(*) 389	151
759	n.s.	n.s.	573	522	356	(*) 871	24
760	178	153	474	616	448	129	64
761	520	1008	763	617	558	123	253
762	n.s.	949	786	1279	762	139	40
763	n.s.	n.s.	840	539	643	(*) 738	17
764	210	200	196	256	156	447	59
765	218	426	270	352	455	293	482
766	n.s.	883	314	415	226	(*) 234	118
767	n.s.	n.s.	146	383	319	(*) 83	12
TOTAL	3179	6859	11305	11246	9331	7134	2380
SD	440	546	860	973	707	638	410

TABLE 6.- Greenland halibut length distribution. Estimated numbers in frequency in ‰. Spanish Spring Survey on NAFO 3NO: 1996-2002. Indet. means indeterminate. 1996-2000 data are transformed C/V *Playa de Menduíña* data. 2001-2002 data are original R/V *Vizconde de Eza* data.

.	1996			1997			1998			1999		
Length (cm.)	Males	Females	Indet.	Males	Females	Indet.	Males	Females	Indet.	Males	Females	Indet.
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.018
10	0.000	0.000	0.000	0.000	0.000	6.165	0.000	0.000	0.000	0.000	2.035	0.000
12	0.000	0.000	2.696	13.453	18.345	25.659	0.000	0.000	2.156	8.140	28.161	3.052
14	0.000	3.605	87.642	23.019	84.520	53.630	0.000	22.692	6.468	15.537	76.364	1.018
16	0.000	6.292	3.169	3.019	4.818	0.472	1.467	3.077	1.718	3.760	5.441	0.000
18	5.825	9.650	0.000	19.203	28.364	0.000	1.438	2.255	0.000	4.188	7.772	0.266
20	89.906	138.485	0.353	114.485	132.770	1.103	19.763	23.913	0.000	21.099	34.011	0.000
22	89.868	167.423	2.303	52.709	63.242	0.000	24.608	29.312	0.535	31.626	45.822	0.000
24	46.398	72.428	1.644	19.698	21.586	0.000	24.822	36.836	0.000	13.516	28.015	0.000
26	14.465	21.614	0.305	15.779	19.923	0.000	30.633	30.528	0.000	8.324	13.813	0.000
28	15.729	26.600	0.000	23.106	27.461	0.000	49.185	66.026	0.000	23.561	19.066	0.000
30	11.686	20.078	0.000	21.198	25.060	0.000	61.645	83.851	0.000	37.805	35.672	0.000
32	9.774	15.171	0.000	10.582	18.145	0.000	47.917	58.085	0.000	49.833	54.367	0.000
34	9.957	14.858	0.000	8.671	12.042	0.000	41.560	48.281	0.000	61.281	67.900	0.000
36	11.140	15.047	0.000	7.225	13.992	0.000	36.009	44.883	0.000	44.834	58.444	0.000
38	7.579	12.302	0.000	6.593	13.708	0.000	27.592	41.366	0.000	28.228	44.859	0.000
40	8.037	12.188	0.000	5.898	11.927	0.000	17.119	27.076	0.000	15.787	28.253	0.000
42	4.938	7.886	0.000	5.771	9.988	0.000	9.275	16.448	0.000	8.728	19.459	0.000
44	3.638	5.906	0.000	4.620	8.627	0.000	5.769	13.105	0.000	5.312	10.951	0.000
46	2.134	6.124	0.000	3.870	7.130	0.000	3.967	8.360	0.000	3.097	7.181	0.000
48	1.698	2.876	0.000	2.555	6.687	0.000	3.093	6.343	0.000	2.018	4.432	0.000
50	0.944	2.870	0.000	2.036	4.497	0.000	2.120	4.619	0.000	1.076	3.546	0.000
52	0.515	1.034	0.000	1.384	3.459	0.000	1.454	2.816	0.000	0.791	1.947	0.000
54	0.179	1.047	0.000	0.992	2.029	0.000	0.860	1.639	0.000	0.517	1.604	0.000
56	0.256	1.285	0.000	0.616	1.563	0.000	0.647	1.487	0.000	0.363	1.068	0.000
58	0.465	0.327	0.000	0.541	1.145	0.000	0.247	1.219	0.000	0.282	0.754	0.000
60	0.070	0.577	0.000	0.349	0.962	0.000	0.284	0.862	0.000	0.203	0.594	0.000
62	0.000	0.226	0.000	0.236	0.738	0.000	0.133	0.288	0.000	0.077	0.352	0.000
64	0.015	0.366	0.000	0.017	0.460	0.000	0.099	0.371	0.000	0.091	0.474	0.000
66	0.010	0.044	0.000	0.048	0.508	0.000	0.105	0.257	0.000	0.024	0.356	0.000
68	0.000	0.044	0.000	0.026	0.414	0.000	0.000	0.187	0.000	0.030	0.223	0.000
70	0.000	0.041	0.000	0.008	0.183	0.000	0.007	0.216	0.000	0.010	0.279	0.000
72	0.000	0.027	0.000	0.000	0.258	0.000	0.000	0.131	0.000	0.000	0.151	0.000
74	0.000	0.057	0.000	0.000	0.162	0.000	0.000	0.155	0.000	0.000	0.265	0.000
76	0.000	0.000	0.000	0.000	0.130	0.000	0.000	0.081	0.000	0.000	0.133	0.000
78	0.000	0.035	0.000	0.000	0.032	0.000	0.000	0.165	0.000	0.000	0.225	0.000
80	0.000	0.018	0.000	0.000	0.178	0.000	0.000	0.114	0.000	0.000	0.244	0.000
82	0.000	0.041	0.000	0.000	0.062	0.000	0.000	0.093	0.000	0.000	0.019	0.000
84	0.000	0.021	0.000	0.000	0.012	0.000	0.000	0.043	0.000	0.000	0.058	0.000
86	0.000	0.025	0.000	0.000	0.000	0.000	0.000	0.049	0.000	0.000	0.049	0.000
88	0.000	0.014	0.000	0.000	0.013	0.000	0.000	0.029	0.000	0.000	0.069	0.000
90	0.000	0.015	0.000	0.000	0.035	0.000	0.000	0.015	0.000	0.000	0.006	0.000
92	0.000	0.015	0.000	0.000	0.086	0.000	0.000	0.009	0.000	0.000	0.000	0.000
94	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.027	0.000	0.000	0.007	0.000
96	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.058	0.000
98	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
100	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
102	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
104	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.009	0.000
Total	335.227	566.661	98.113	367.711	545.261	87.029	411.817	577.306	10.877	390.140	604.506	5.353
Nº Ind.:	2867	4667	60	3444	5550	55	4470	7080	14	4012	6533	6
Nº samples:		52			75			84			78	
Range:		12-91			10-92			11-94			7-104	
Total catch:		520			1243			1885			1898	
Sampled catch:		2380.090			4198.357			5803.875			5642.920	
Total hauls:		112			128			124			114	

TABLE 6 (cont.).- Greenland halibut length distribution. Estimated numbers in frequency in ‰. Spanish Spring Survey on NAFO 3NO: 1996-2002. Indet. means indeterminate. 1996-2000 data are transformed C/V *Playa de Menduíña* data. 2001-2002 data are original R/V *Vizconde de Eza* data.

.	2000			2001			2002		
Length (cm.)	Males	Females	Indet.	Males	Females	Indet.	Males	Females	Indet.
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	0.000	0.000	0.000	0.997	3.132	4.283	3.021	8.974	5.261
12	39.420	42.235	11.263	19.600	44.265	22.619	51.745	50.223	4.510
14	73.207	140.633	14.078	60.269	111.261	30.911	85.418	88.423	3.006
16	10.297	13.953	0.000	53.140	73.336	3.286	21.755	26.993	0.000
18	9.561	10.297	0.000	4.882	4.765	0.000	0.752	1.503	0.000
20	10.297	11.032	0.000	23.258	29.579	0.000	3.747	4.509	0.000
22	2.479	4.361	0.000	87.383	70.428	0.000	23.222	19.446	0.000
24	8.556	9.304	0.000	53.671	69.952	0.000	36.728	46.427	0.000
26	7.333	10.562	0.113	10.028	12.637	0.000	24.749	37.506	0.000
28	3.744	6.060	0.000	3.785	2.492	0.000	7.481	9.729	0.000
30	4.514	6.470	0.000	0.997	2.492	0.000	9.729	10.490	0.000
32	9.840	10.590	0.000	6.276	4.384	0.000	18.017	26.259	0.000
34	15.725	20.044	0.000	3.986	5.481	0.000	9.727	29.168	0.000
36	24.956	30.087	0.000	6.479	11.959	0.000	20.988	24.765	0.000
38	34.988	44.744	0.000	12.457	13.456	0.000	17.238	18.741	0.000
40	30.731	57.470	0.000	9.468	16.451	0.000	11.252	35.227	0.000
42	28.122	54.935	0.000	11.959	17.441	0.000	13.515	26.206	0.000
44	18.740	48.651	0.000	4.485	21.925	0.000	11.966	34.533	0.000
46	10.986	29.106	0.000	2.990	15.455	0.000	12.015	14.257	0.000
48	5.614	18.491	0.000	2.000	13.454	0.000	3.757	19.508	0.000
50	3.920	11.612	0.000	0.000	6.976	0.000	8.932	20.277	0.000
52	3.195	7.462	0.000	0.000	2.492	0.000	3.006	8.252	0.000
54	1.649	5.243	0.000	0.498	1.993	0.000	0.752	7.513	0.000
56	1.589	4.699	0.000	0.000	0.498	0.000	1.500	5.261	0.000
58	0.740	2.858	0.000	0.000	0.997	0.000	0.000	3.006	0.000
60	0.379	2.042	0.000	0.000	0.000	0.000	0.000	1.502	0.000
62	0.493	2.059	0.000	0.000	0.997	0.000	0.000	0.748	0.000
64	0.093	1.143	0.000	0.000	0.498	0.000	0.000	1.503	0.000
66	0.082	0.982	0.000	0.000	0.000	0.000	0.000	0.000	0.000
68	0.155	1.094	0.000	0.000	0.498	0.000	0.000	1.502	0.000
70	0.000	0.751	0.000	0.000	0.000	0.000	0.000	0.000	0.000
72	0.000	0.677	0.000	0.000	0.000	0.000	0.000	0.000	0.000
74	0.000	0.590	0.000	0.000	0.000	0.000	0.000	0.000	0.000
76	0.000	0.534	0.000	0.000	0.498	0.000	0.000	0.000	0.000
78	0.000	0.424	0.000	0.000	0.505	0.000	0.000	0.752	0.000
80	0.000	0.749	0.000	0.000	0.000	0.000	0.000	0.000	0.000
82	0.000	0.400	0.000	0.000	0.000	0.000	0.000	0.752	0.000
84	0.000	0.288	0.000	0.000	0.000	0.000	0.000	0.000	0.000
86	0.000	0.291	0.000	0.000	0.000	0.000	0.000	0.000	0.000
88	0.000	0.061	0.000	0.000	0.000	0.000	0.000	1.503	0.000
90	0.000	0.056	0.000	0.000	0.000	0.000	0.000	0.752	0.000
92	0.000	0.064	0.000	0.000	0.000	0.000	0.000	0.000	0.000
94	0.000	0.037	0.000	0.000	0.000	0.000	0.000	0.000	0.000
96	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
98	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
100	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
102	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
104	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	361.405	613.142	25.454	378.605	560.295	61.100	401.013	586.210	12.777
Nº Ind.:	2991	6162	10	445	739	80	535	782	17
Nº samples:		81			44			76	
Range:		11-94			10-78			9-89	
Total catch:		1437			332			429	
Sampled catch:		6845.142			290.890			429.780	
Total hauls:		118			83			125	

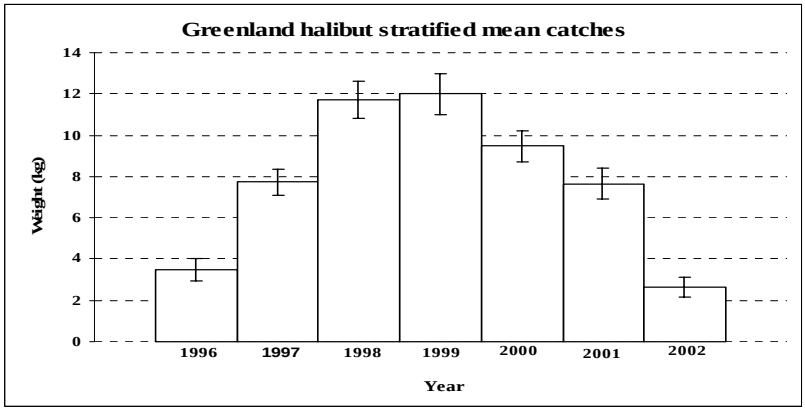

FIGURE 1.- Greenland halibut stratified mean catches in Kg and ±SD by stratum and year. Spanish Spring surveys on NAFO Div. 3NO: 1996-2002 (1996-2000 transformed data from C/V *Playa de Menduíña*; 2001-2002 original data from R/V *Vizconde de Eza*).

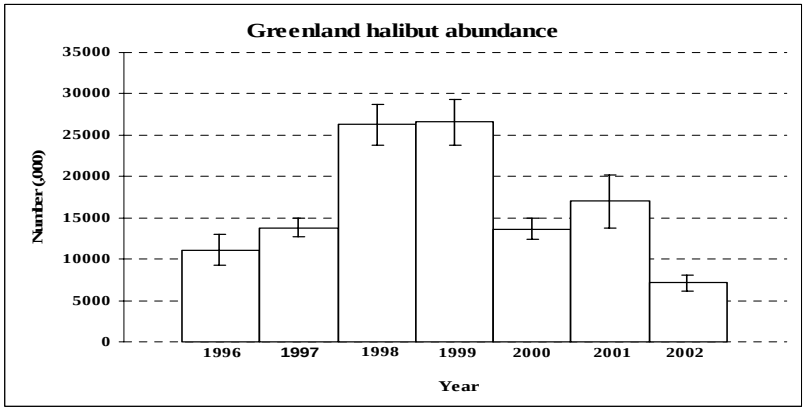

FIGURE 2.- Greenland halibut abundance in thousand and ±SD by stratum and year. Spanish Spring surveys on NAFO Div. 3NO: 1996-2002 (1996-2000 transformed data from C/V *Playa de Menduíña*; 2001-2002 original data from R/V *Vizconde de Eza*).

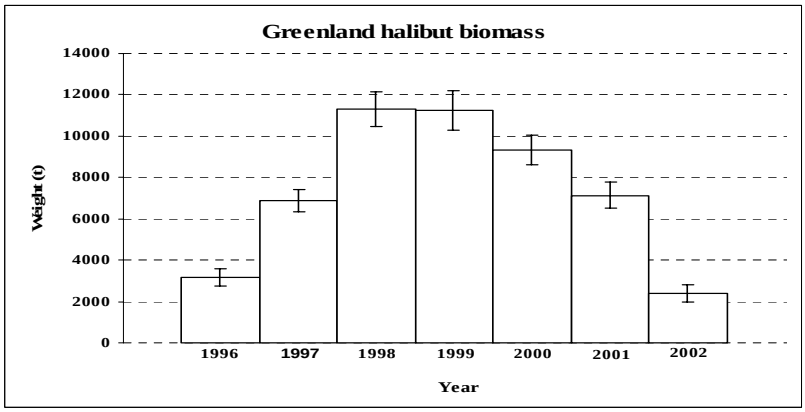

FIGURE 3.- Greenland halibut biomass in tons and ±SD by stratum and year. Spanish Spring surveys on NAFO Div. 3NO: 1996-2002 (1996-2000 transformed data from C/V *Playa de Menduíña*; 2001-2002 original data from R/V *Vizconde de Eza*).

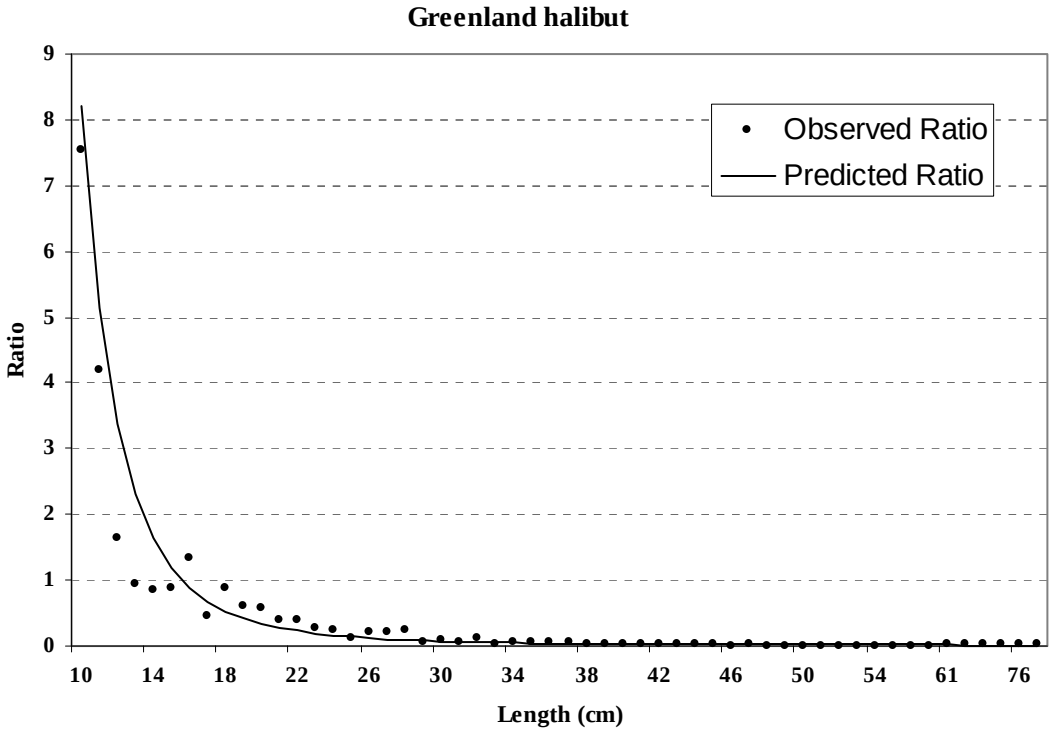

FIGURE 4.- Ratios of *Campelen* catch to *Pedreira* catch, by length group, of Greenland halibut, from comparative fishing trials between the two gears on the C/V *Playa de Menduíña* and the R/V *Vizconde de Eza*. The dots are the observed ratios and the curve is the fitted line.

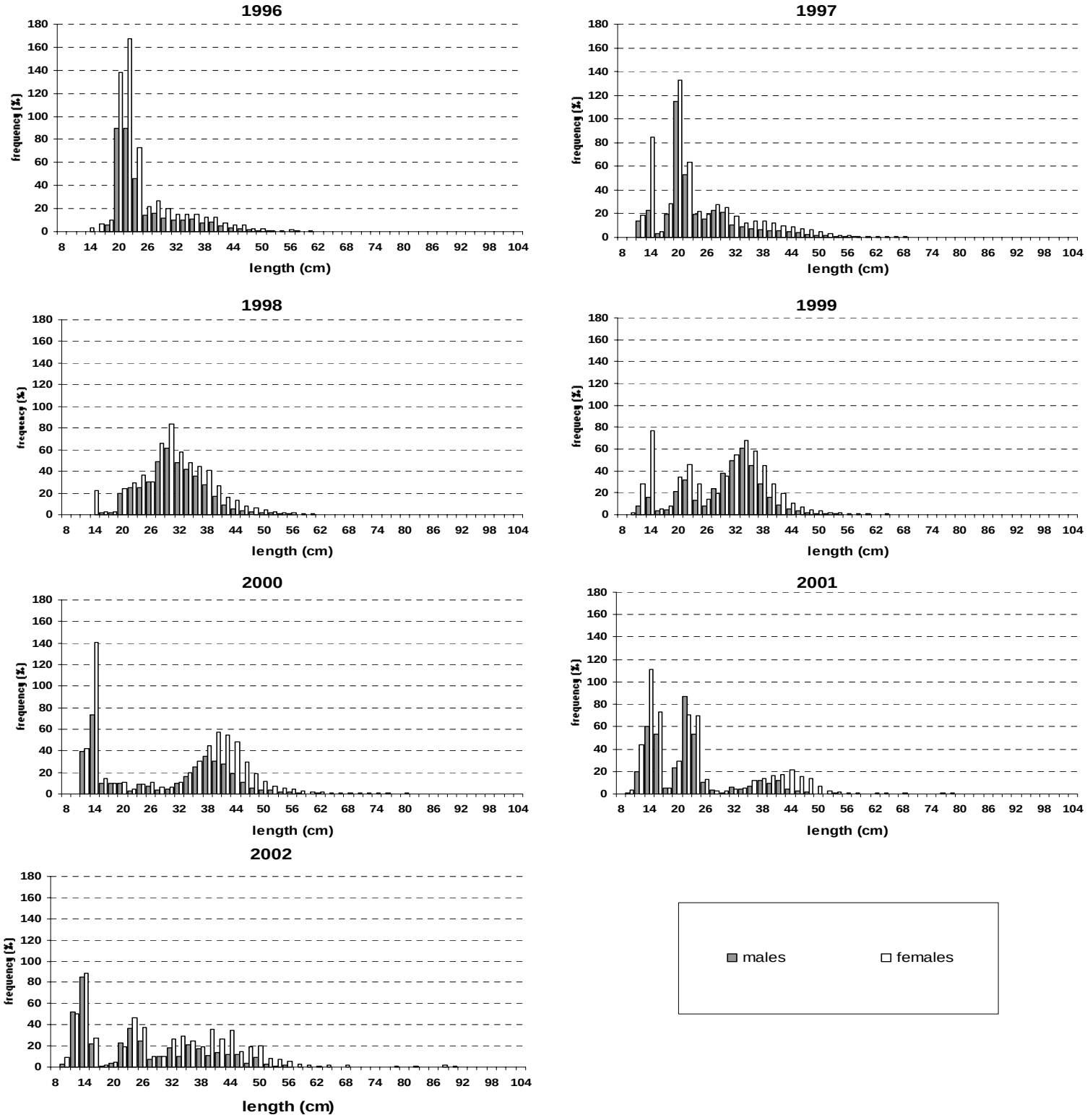

FIGURE 5.- Greenland halibut length distribution (cm) on NAFO 3NO: 1996-2002. Frequency in ‰. 1996-2000 data are transformed data from C/V *Playa de Menduíña*, and 2001-2002 data are original from R/V *Vizconde de Eza*