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Witch Flounder (*Glyptocephalus cynoglossus*) in the Spanish Fishery in  
NAFO Regulatory Area (Divisions 3LM and 3NO) 1991-94

by

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**ABSTRACT**

The by-catch of witch flounder in the Greenland halibut Spanish fishery in the NAFO Regulatory Area was analyzed during the period 1991 to 1994. A total of 32483 hauls were sampled. Data from 3NO Spanish bottom trawl survey were also included in this analysis. Total catch was estimated for this period, showing high variability both by division and by year. The maximum was reached in 1994 in NAFO Div. 3NO. The yield shows seasonality. It was greater in March-April. In the period 1992-96, the annual yield shows a increasing. The length distribution and the length/weight relationships was obtained in a deep range of 1500m. The length range was 24-58 in males and 26-62 in females. The mean length decreased through the period analysed, and it was higher in the large vessel catches. The individuals were also larger in 3M division. The sex ratio showed seasonal variation in the large vessels catches, while any clear trend appears in the small ones. In addition to Greenland halibut, which was the target species, the main accompanying species of the witch flounder catches were: redfish, grenadiers, skate and occasionally American plaice.

**INTRODUCTION**

The witch flounder (*Glyptocephalus cynoglossus*) populations in NAFO divisions 2J3KL and 3NO have declined in the last years (Bowering, 1995; Bowering, 1996). There is not any recommendation for the 2K3KL stock. Very little information is available due to the moratorium on directed fishing in 3NO. Moreover, the published data from research trawl surveys are referred to limited deep range, not greater than 850m., which do not include all distribution area of this specie (Gorchinsky et al., 1995; Paz and Casas, 1996 SCS; Durán et al., 1996).

Witch flounder is a by-catch specie in the Spanish deep waters fishery. This fishery is described in Junquera and Iglesias, (1992). It is caught during all year in variable quantity, and sometimes at great depth: 1500 m (Durán et al, 1996).

In this paper the data from the observers program on board the Spanish bottom trawl vessels operating in the NAFO Regulatory area is analysed during the period 1991 to 1994. This study provides information about the deeper distribution of the population and allow to estimate some biological parameters of the stock.

## MATERIAL AND METHODS

The sampling effort here considered comprised the period 1991 to December 1994, and reached 1500 metres of depth (Durán et al, 1996). The total hauls sampled were 23413 in the large vessels and 9070 in the small ones. The distribution of samples by month through the period 1991-1994 appears in Table 1. A total of 3724 individuals were sampled.

The length was taken by sex and to the nearest centimetre. 9889 individuals were measured on board of the large vessels, 17974 individuals in the small vessels and 2469 in the Spanish survey. The total ungutted weight of each fish was recorded in grammes with a precision of the  $\pm 5$ gr. The number of length-weight samples and the individuals involved by division and year appear in Figure 10.

To obtain the sex ratio the individuals sampled from the length distribution were used.

For the length-total weight relationship a function of the form  $W = aL^b$  was fitted to the data, where  $W$ = weight (g) and  $L$ = length (cm). The weight at length relationships have been estimated for each year and division.

## RESULTS

The fishing effort in the 3NO division increasing in the last year (Junquera, 1994), as indicate the sample distribution (Table 1).

The annual total catches were higher in the large vessels than the small ones all years considered (Table 2). The maximum was reached in the early spring (Figure 1). The catches from 3NO divisions increased in the last year analyzed (1994) for both fleets, compared with the 3L catches, which were higher in previous years: 1992 and 1993 (Figure 1).

The yield by month, fleet and year appears in figure 2. The peak occurs from February to April. This is in agreement with the literature (Pechenik et al., 1971; Bowring, 1994).

Annual yield shows a increasing trend (Figure 2b) though the correspondent fishing effort was very variable.

The main species accompanying the witch flounder in the catches are shown in the Table 3. Beside the target species: greenland halibut, other by-catch species were: the skates, grenadiers, american plaice and redfish. Shows up in the last year the high skate catches in 3NO Division. This seems to indicate a recent change in the fishing strategy, directing the effort to no regulated species.

The length distribution by sex division and year from commercial vessels and bottom trawl survey by year and division appear in the tables 4 to 6 and in figures 3 to 5. In 3NO Division the juveniles proportion was smaller than in the 3M Division for the two fleets. The maximum length was the same: 62 cm. The mean length in the commercial catches decreased slightly through the period analysed (Figure 6). This trend can be due to an increase in the fishing depth, as a negative size correlation with depth, mainly in summer and autumn, is found

in this species (Burnett et al, 1992, Paz and Casas, 1996). In the 3NO Spanish bottom trawl survey the decrease in the mean length can be due to the recruitment of the recent year-classes.

In the large vessels the sex ratio shows a higher proportion of males for all divisions in 1993 compared to 1994. In 1993 the proportion of males reaches the 75% at 42 cm and 100% at 45 cm (Figure 7). There are no evident reason for it. In the small vessels any clear trend appears in the sex ratio through the period (Figure 8). The male proportion from the spanish survey data was higer in 1995 than 1996 (Figure 9).

Plots for length/weight relationships by year and divison are show in figure 10.

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**Table 1.- Monthly distribution by Division and year of the sampled hauls. Spanish deep sea fishery.**  
 A: Large vessels 1991-94; B: Small vessels 1992-94.

**A: LARGE VESSELS**

Month	DIV. 3L				DIV. 3M				DIV. 3N0				TOTAL				
	1991	1992	1993	1994	1991	1992	1993	1994	1991	1992	1993	1994	1991	1992	1993	1994	
Jan		178	256	137		231	23	71				1		409	279	209	
Feb		468	382	197		752	61	202				24		1270	443	423	
Mar		463	334	52		1021	200	283		3	23	163		1487	557	498	
Apr		1006	269	121		498	190	182			28	200		1504	487	503	
May		1398	205	191		370	54	163			78	239		1768	337	593	
Jun		799	98	110		299	54	112			15	164		1098	167	386	
Jul	81	286	2	65	324	79		30		9	149	75		405	374	170	
Aug	477	320	78	137	695	114	21	30		190	348	97		1172	624	264	
Sep	432	285	139	118	709	30	22	39		2	129	121	95	1143	444	252	
Oct	415	201	71	159	763	14	39	70		17	73	129	105	1195	288	334	
Nov	322	246	191	268	826	24	2	29		1	12	147	53	1149	282	350	
Dec	229	148	214	230	230	19	17	2				51		459	167	232	
<b>Total</b>	<b>1956</b>	<b>5798</b>	<b>2239</b>	<b>1785</b>	<b>3547</b>	<b>3451</b>	<b>683</b>	<b>1213</b>		<b>20</b>	<b>416</b>	<b>1089</b>	<b>1216</b>	<b>5523</b>	<b>9665</b>	<b>4214</b>	
<b>Total 3L :</b>	<b>11778</b>				<b>Total 3M :</b>	<b>8894</b>				<b>Total 3N0 :</b>	<b>2741</b>			<b>Total hauls :</b>	<b>23413</b>		

Total towed hours: 123442  
 Mean tow time : 5 h 16 min

**B: SMALL VESSELS**

Month	DIV. 3L			DIV. 3M			DIV. 3N0			TOTAL					
	1992	1993	1994	1992	1993	1994	1992	1993	1994	1992	1993	1994			
Jan		78	33		19	32					97	65			
Feb		339	8		108	4		2	119		449	131			
Mar		414	16		201	13		83	165		698	194			
Apr		325	12		179	7		309	185		813	204			
May		473	7		58	4		240	185		771	196			
Jun		249	33		44	8		252	72		545	113			
Jul	100	146	7	40	26	1		342	2		140	514			
Aug	113	178	20	35	4	1		44	272	90	192	454			
Sep	139	179	31	22	1	6		282	213	117	443	393			
Oct	60	59		17				320	406	150	397	465			
Nov	10	1		6	3	6		250	436	192	266	440			
Dec	98	89	10	26	24			11	115	94	135	228			
<b>Total</b>	<b>520</b>	<b>2530</b>	<b>177</b>	<b>146</b>	<b>667</b>	<b>82</b>		<b>907</b>	<b>2670</b>	<b>1371</b>	<b>1573</b>	<b>5867</b>			
<b>Total 3L:</b>	<b>3227</b>			<b>Total 3M:</b>	<b>895</b>			<b>Total 3N0:</b>	<b>4948</b>			<b>Total hauls:</b>	<b>9070</b>		

Total towed hours: 44054  
 Mean tow time : 4 h 51 min

**Table 2.- Total catch (Kg) of Witch Flounder by NAFO Division and Year. Spanish Greenland Halibut Fishery 1991-1994, Large Vessels and Small Vessels.**

Year	Large Vessels				Small Vessels			
	Div. 3L	Div. 3M	Div. 3N0	TOTAL	Div. 3L	Div. 3M	Div. 3N0	TOTAL
1991	640	1651	6774	9065				
1992	132558	3554	2267	138379	2580	15007	95546	113133
1993	416565	17112	152646	586323	229073	18391	189956	437420
1994	146667	11586	353190	511443	54096	9976	374560	438632

**Table 3.-** Mean catches (Kg) of the main species in the sampled hauls with Witch Flounder presence by NAFO Divs. and year. Spanish Greenland Halibut fishery, 1991-1994. A: Large Vessels; B: Small Vessels  
 N° = number of sampled hauls with Wich Flounder presence; % = percentage of total hauls sampled.

Year Division	1991	1992		1993			1994		
	3L	3L	3M	3L	3M	3NO	3L	3M	3NO
N° (%)	34 (2)	1245 (19.3)	226 (6.5)	1021 (42.5)	79 (11.3)	446 (39.1)	661 (30.1)	88 (7)	829 (72.6)
Mean Depth (m)	816	971	1076	1037	980	999	951	1017	967
GHL	1011	1907	1796	1856	1648	1037	1438	1384	1308
SKA	13	228	24	122	17	289	63	38	874
PLA	141	52	2	118	7	36	161	10	204
RHG	301	152	102	193	102	296	106	86	187
RED	102	99	19	131	224	33	68	20	66
CAT	1	23	22	21	23	14	32	20	26
WIT	476	94	15	127	68	97	66	41	153
RNG	48	26	472	14	35	11	5	49	22
BSH	0	5	9	4	25	3	31	0	467
179	0	2	14	2	2	2	315	11	0
DOG	0	7	20	10	7	7	2	5	61
166	0	16	17	8	11	24	20	30	36
ANT	0	3	31	16	3	11	2	2	32

A

Year Division	1992	1993	1994		
	3L	3L	3L	3M	3NO
N° (%)	88 (15.3)	808 (29.5)	75 (34)	22 (26)	848 (48)
Mean Depth (m)	894	962	973	1034	955
GHL	1335	917	1382	1259	1683
SKA	12	158	56	22	439
PLA	0	92	30	31	742
RHG	79	131	127	119	304
RED	28	43	35	13	186
CAT	4	25	14	10	10
WIT	129	160	180	113	233
RNG	13	28	21	18	185
DOG	2	4	2	0	153
166	10	32	8	5	52
ANT	2	15	19	29	8
HKR	0	0	0	18	0

B

Table 4.- Witch Flounder Length distribution by NAFO Divisions and year. Spanish Greenland Halibut Fishery 1992-1994.  
Large vessels. I = Individuals; S = Samples.

Length groups (cm)	Div 3L (Frequency %)						
	1992		1993			1994	
	Combined	Males	Females	Combined	Males	Females	Combined
22	0	0	1	1	0	0	0
24	0	0	0	0	0	0	0
26	0	0	0	0	5	8	13
28	3	1	2	2	12	7	19
30	18	3	1	4	10	15	25
32	22	5	4	9	11	15	25
34	46	10	6	16	15	13	28
36	28	16	22	39	33	33	66
38	30	35	33	68	57	60	117
40	44	52	38	90	60	82	142
42	95	70	44	114	51	82	133
44	134	100	46	146	37	63	100
46	119	81	64	144	44	64	108
48	148	58	69	127	17	55	71
50	110	23	68	91	11	50	61
52	84	10	54	64	2	46	48
54	55	1	40	41	1	25	26
56	37	1	25	26	1	12	13
58	12	0	11	11	0	4	4
60	13	0	5	5	0	1	1
62	1	0	2	2	0	0	0
64	0	0	0	0	0	1	1
66	0	0	0	0	0	0	0
68	1	0	0	0	0	0	0
I	1209			3503			1776
S	10			22			10

Length groups (cm)	Div 3M (Frequency %)				Div 3NO (Frequency %)					
	1992		1993		1993			1994		
	Combined	Males	Females	Combined	Males	Females	Combined	Males	Females	Combined
26	0	0	0	0	0	0	0	0	0	0
28	0	6	0	6	0	0	0	0	0	0
30	5	12	0	12	1	0	1	6	8	14
32	5	12	12	23	0	0	0	21	24	45
34	11	17	6	23	6	1	8	45	56	101
36	5	29	12	41	23	5	28	53	72	126
38	26	17	29	46	43	20	63	43	81	124
40	26	47	23	70	45	25	70	47	64	110
42	63	47	6	52	31	47	78	32	58	90
44	188	134	0	134	38	59	97	33	58	91
46	73	105	47	151	35	99	134	26	58	84
48	136	41	64	105	34	123	157	14	60	73
50	177	29	64	93	29	119	148	12	40	52
52	130	17	76	93	17	90	108	10	42	53
54	63	6	58	64	11	58	69	1	20	21
56	63	0	52	52	4	17	21	4	6	10
58	21	0	23	23	1	14	16	0	2	2
60	5	0	12	12	0	2	2	0	1	1
62	5	0	0	0	0	2	2	0	0	0
I	192			172			1081			1956
S	2			1			14			12

**Table 5.** - Witch Flounder Length distribution by NAFO Divisions and year. Spanish Greenland Halibut Fishery 1992 - 1994, Small vessels. I = Individuals; S = Samples.

Length groups (cm)	Div 3L (Frequency %)				Div 3M (Frequency %)	
	1993		1994		1993	
	Males	Females	Males	Females	Males	Females
24	0	0	0	0	0	0
26	0	1	0	0	4	0
28	1	1	8	0	0	0
30	3	2	31	0	4	0
32	5	3	29	0	4	4
34	9	8	24	6	13	11
36	20	15	50	15	17	11
38	29	20	100	21	22	28
40	49	23	139	57	34	34
42	81	34	86	121	64	57
44	110	40	57	102	83	70
46	89	57	18	51	36	81
48	55	73	22	20	30	79
50	22	75	6	29	32	100
52	9	69	0	4	4	92
54	3	51	0	0	2	38
56	1	26	0	4	0	34
58	0	10	0	0	0	8
60	0	6	0	0	0	4
62	0	1	0	0	0	0
64	0	0	0	0	0	0
66	0	0	0	0	0	0
68	0	0	0	0	0	0
70	0	0	0	0	0	0
72	0	0	0	0	0	0
I	8296		212		348	
S	50		2		2	

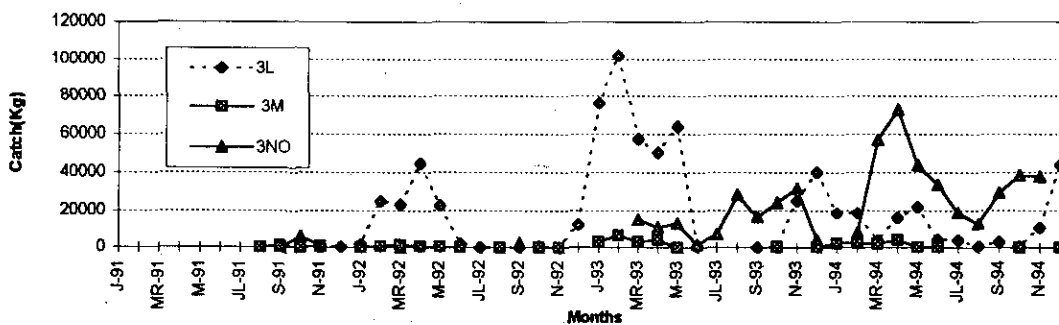
Length groups (cm)	Div 3NO (Frequency %)					
	1992		1993		1994	
	Males	Females	Males	Females	Males	Females
26	0	0	0	0	0	0
28	0	0	1	0	1	0
30	0	0	0	1	7	14
32	0	4	1	1	28	37
34	13	19	9	11	39	76
36	21	60	33	33	55	111
38	66	58	55	64	64	113
40	82	55	52	86	41	108
42	128	52	34	78	19	77
44	58	73	22	100	11	58
46	58	65	9	110	3	50
48	23	58	3	124	5	33
50	5	46	1	80	1	26
52	0	23	0	55	0	11
54	0	13	0	22	0	10
56	5	9	0	7	0	2
58	1	2	0	6	0	1
60	0	2	0	1	0	0
62	0	0	0	0	0	0
64	0	0	0	0	0	0
66	0	1	0	0	0	0
I	870		4176		4074	
S	17		26		24	

**Table 6.- Witch Flounder Length Distribution. Spanish Bottom Trawl Survey, May 1995-1996.**  
 I = Individuals; S = Samples.

Length groups (cm)	Frequency %.			
	May 1995		May 1996	
	Males	Females	Males	Females
20	1	0	0	2
22	1	0	0	2
24	2	1	4	3
26	3	5	5	10
28	1	7	19	30
30	5	10	37	59
32	14	18	49	103
34	50	50	77	128
36	86	58	52	115
38	76	77	29	72
40	56	72	20	49
42	32	94	14	34
44	27	56	8	19
46	19	48	3	20
48	9	39	1	14
50	6	29	1	9
52	0	22	0	3
54	1	11	0	3
56	0	12	0	2
58	0	3	0	3
60	0	0	0	0
62	0	1	0	0
<b>TOTAL</b>	<b>388</b>	<b>612</b>	<b>319</b>	<b>681</b>
I		857		1612
S		35		15



**LARGE VESSELS**



**SMALL VESSELS**

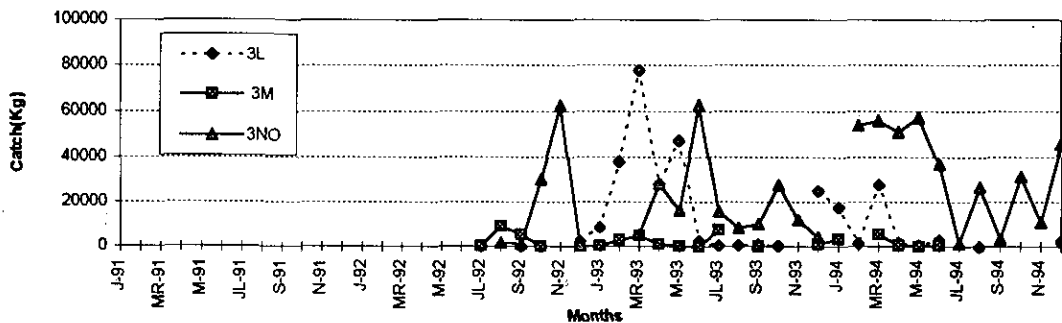
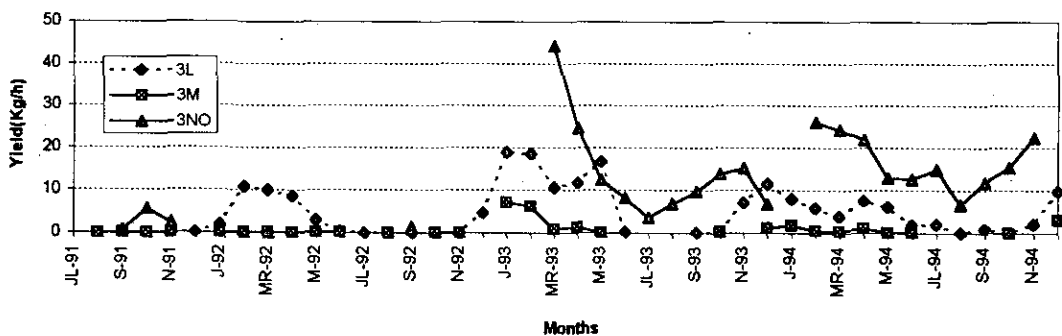


Fig 1.- Witch Flounder catches (Kg) by Division, year and month. Spanish Greenland Halibut fishery. 1991-1994. Large Vessels and Small Vessels.

**LARGE VESSELS**



**SMALL VESSELS**

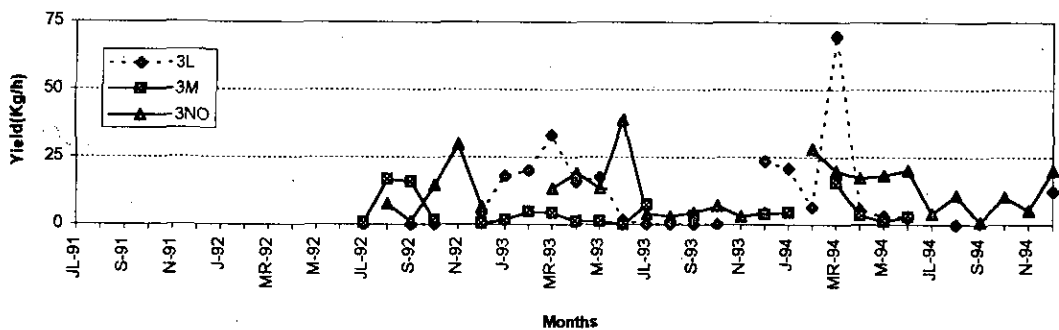


Fig 2a.- Witch Flounder yield (Kg/h) by Division, year and month. Spanish Greenland Halibut fishery. 1991-1994. Large Vessels and Small Vessels.

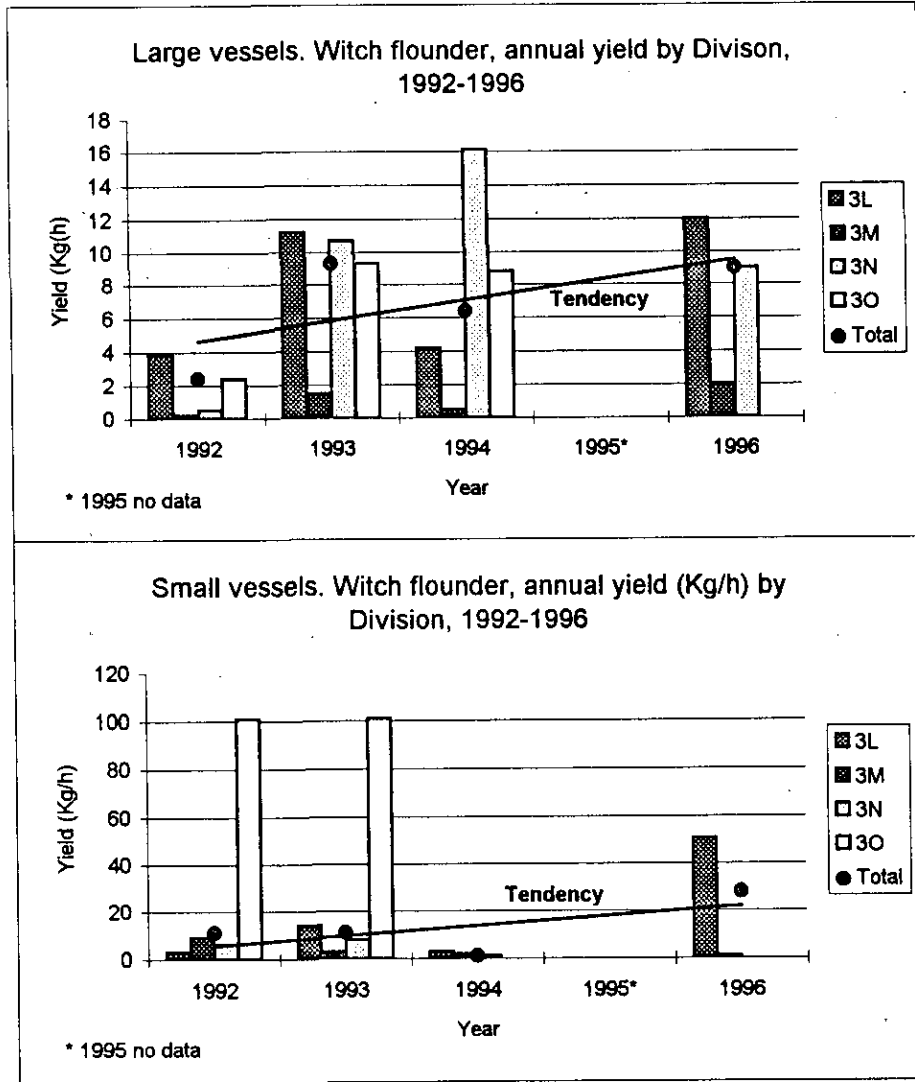


Figure 2b.- Witch flounder. Annual yield (Kg/h) by fleet and division, 1992-1996.

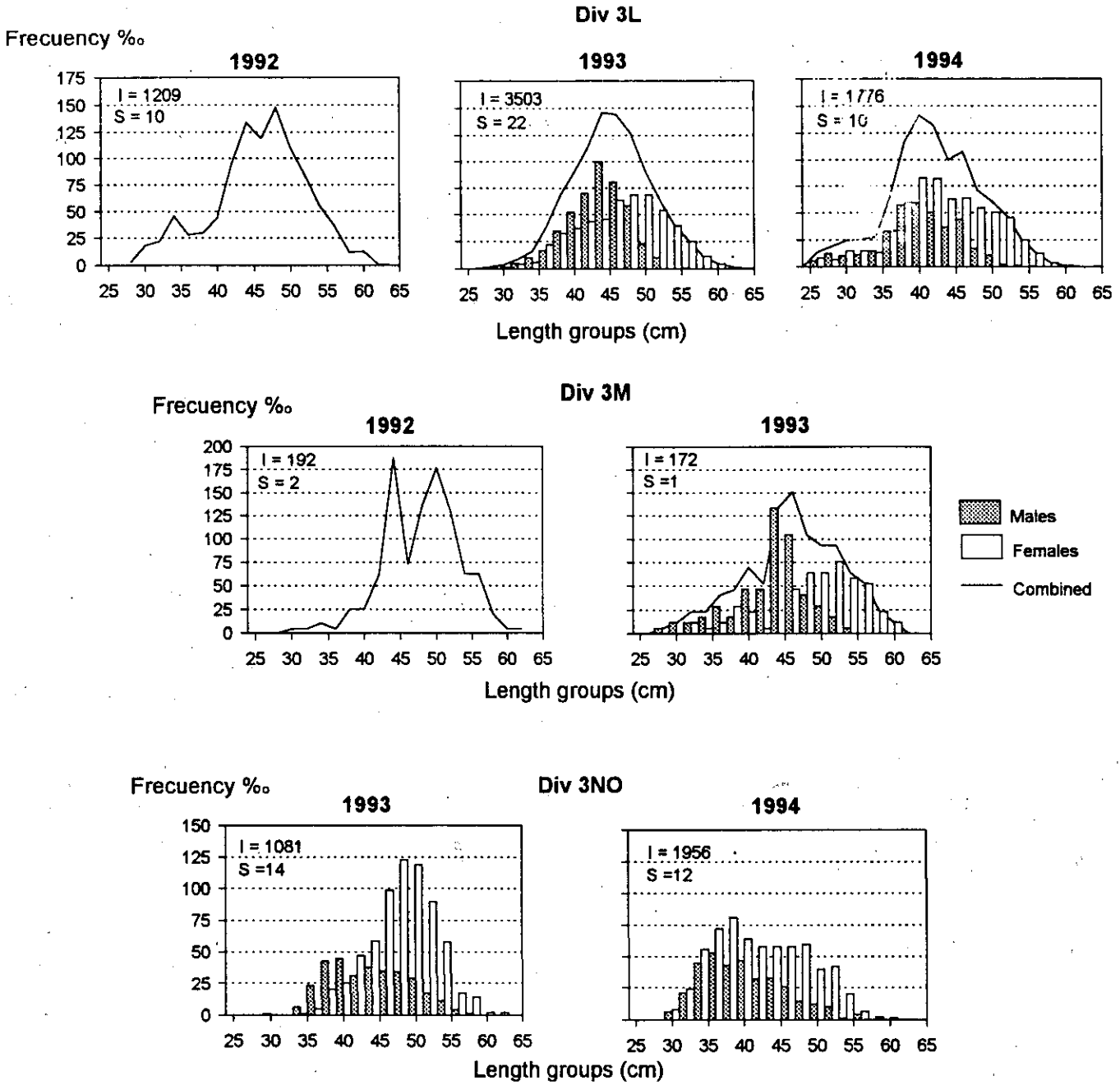


Fig 3.- Wich Flounder length distribution by NAFO Divisions and year. Spanish Greenland Halibut fishery. 1992-1994, Large Vessels. I = Individuals; S = Samples.

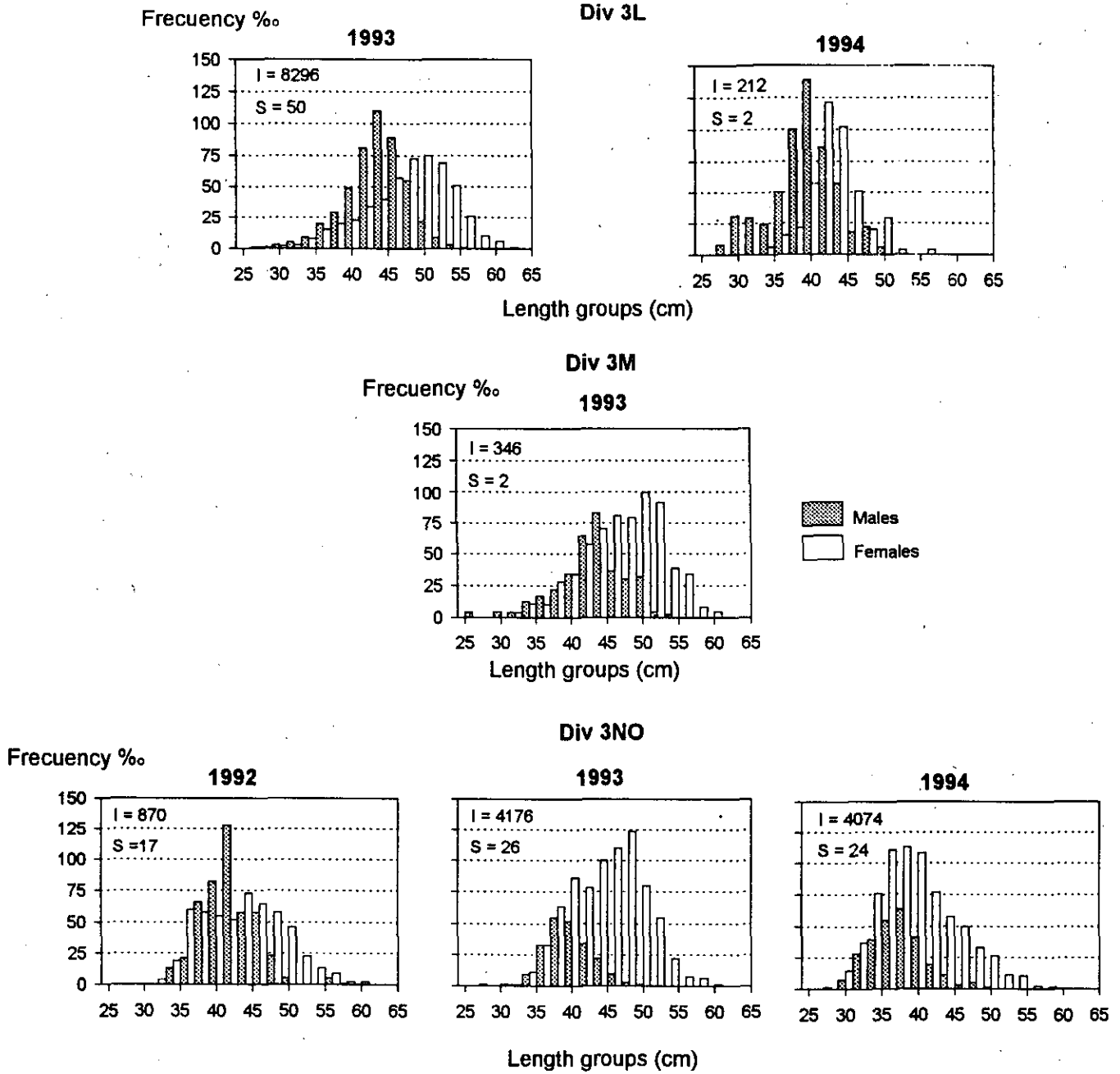
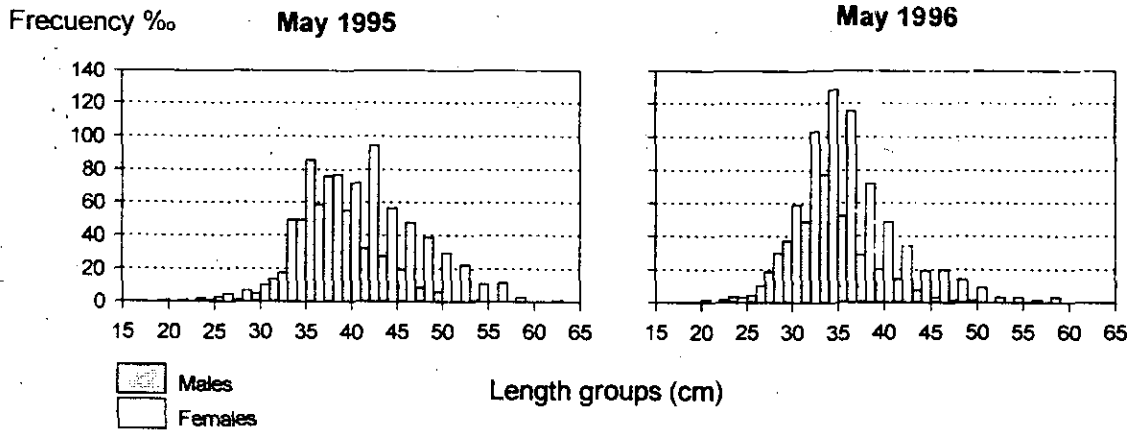
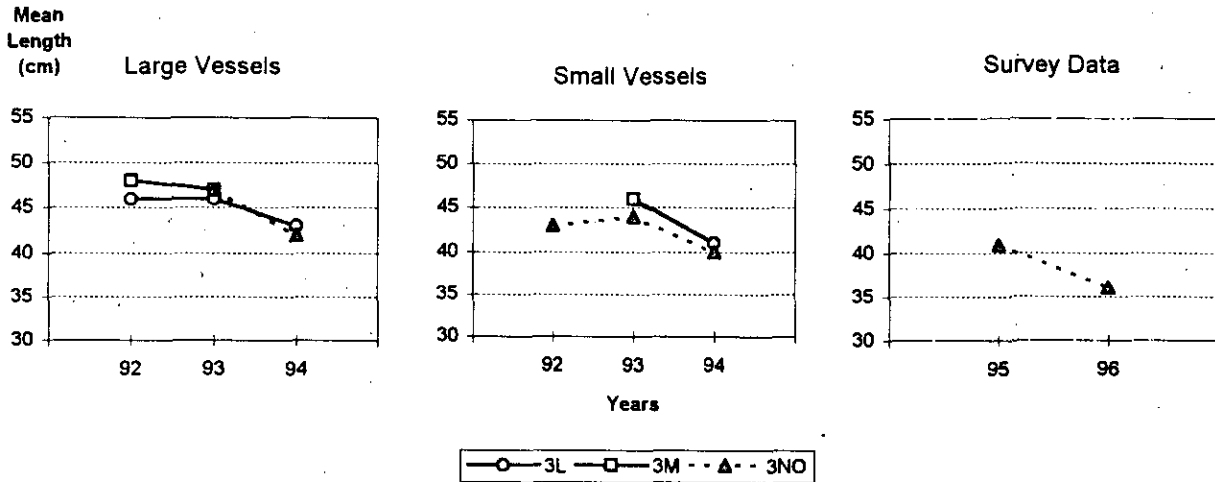


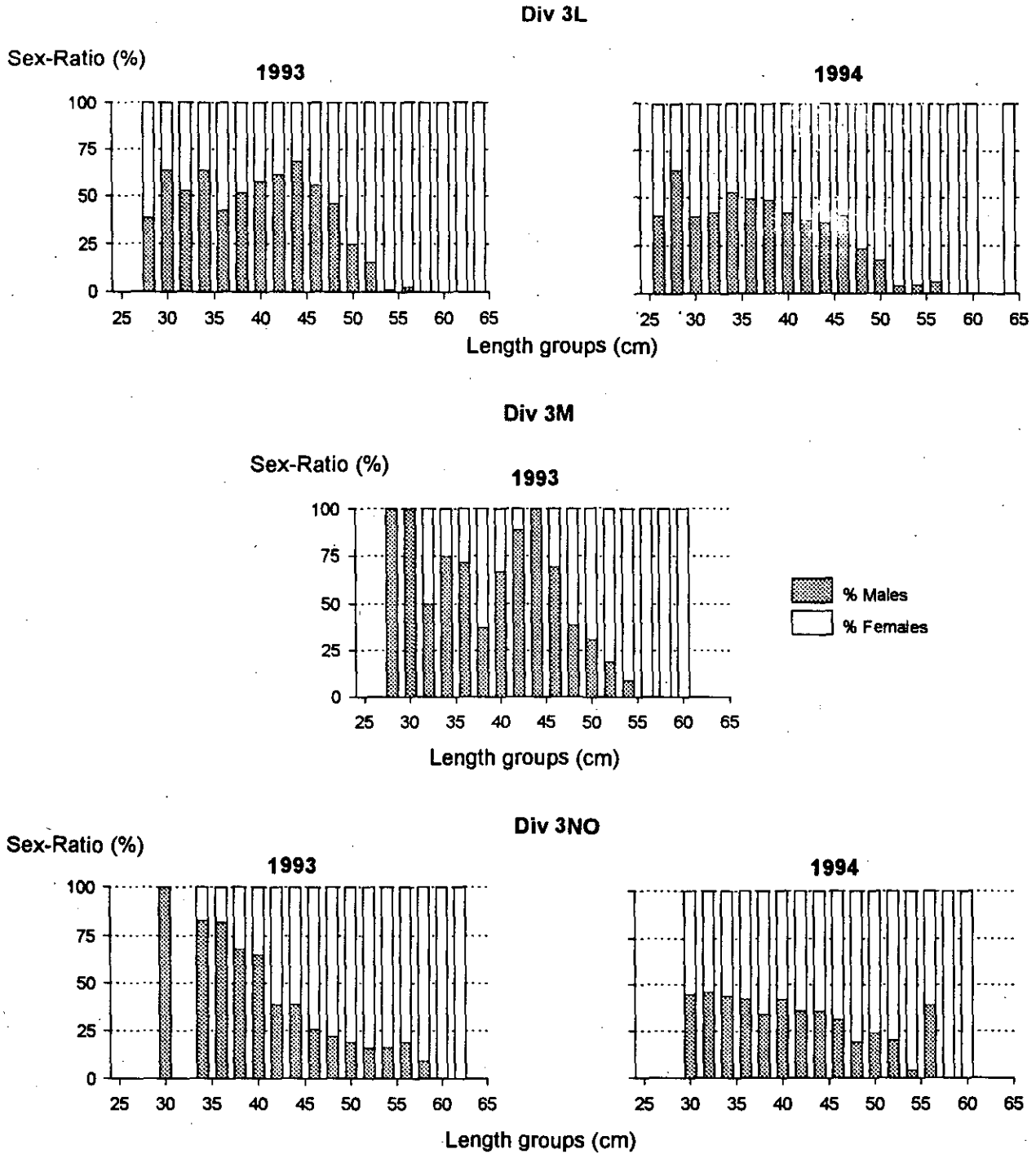
Fig 4.- Wich Flounder length distribution by NAFO Divisions and year. Spanish Greenland Halibut fishery. 1992-1994, Small Vessels. I = Individuals; S = Samples.



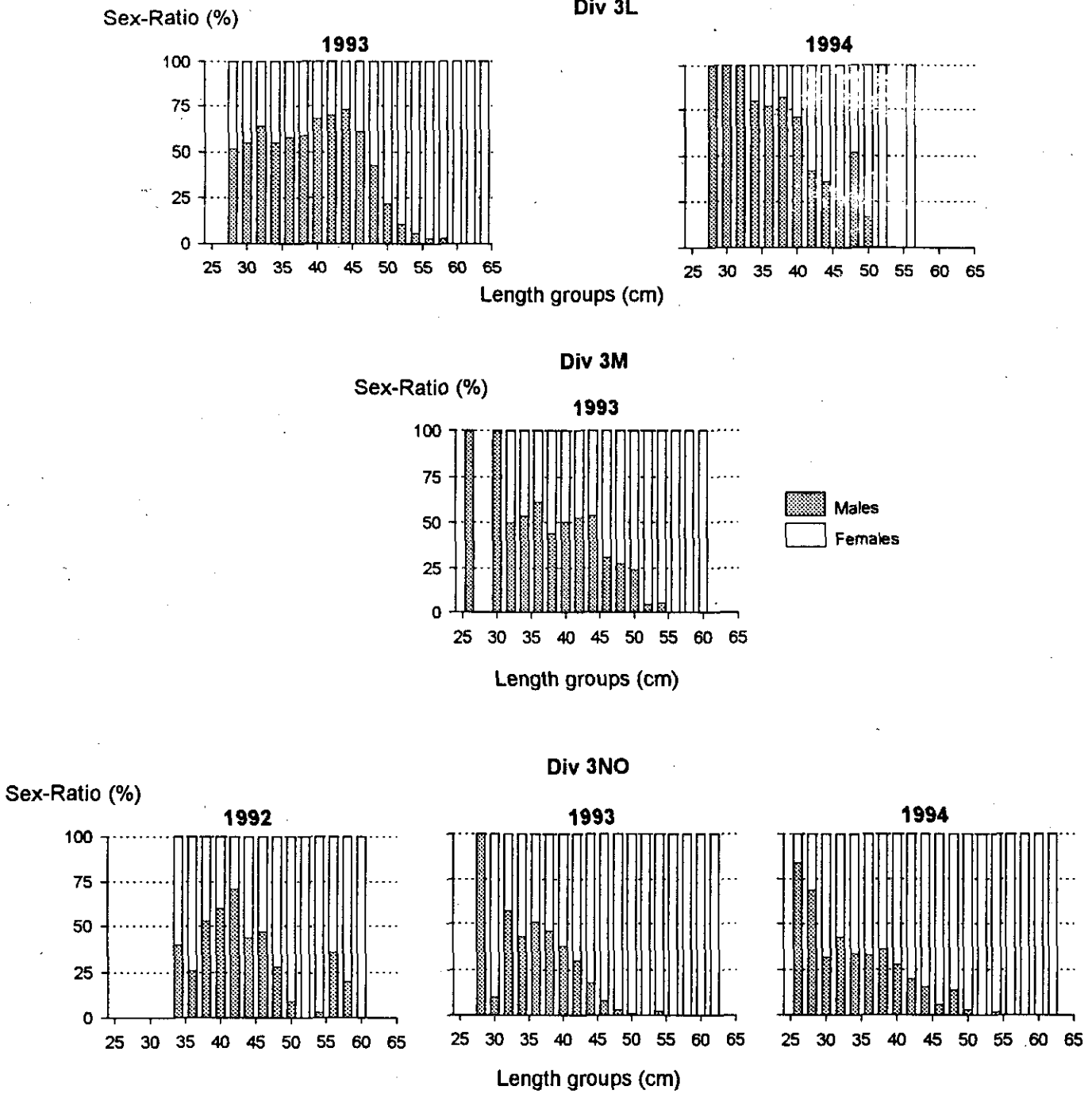
**Fig 5.-** Length distribution of Witch Flounder in NAFO Regulatory Area (Div 3NO). Spanish Bottom Trawl Survey. May 1995 and May 1996. I = Individuals; S = Samples.



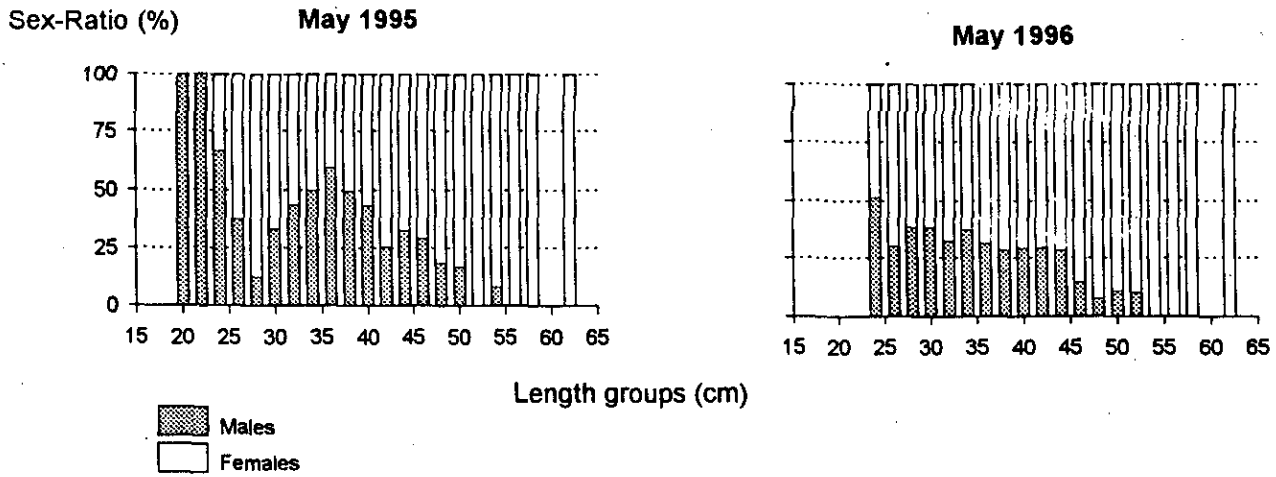
**Fig 6.-** Witch Flounder mean length (cm), by year and NAFO Division. Spanish Greenland Halibut fishery 1992-1994: Large vessels and Small vessels, and Spanish Bottom Trawl Survey for 3NO Divs.



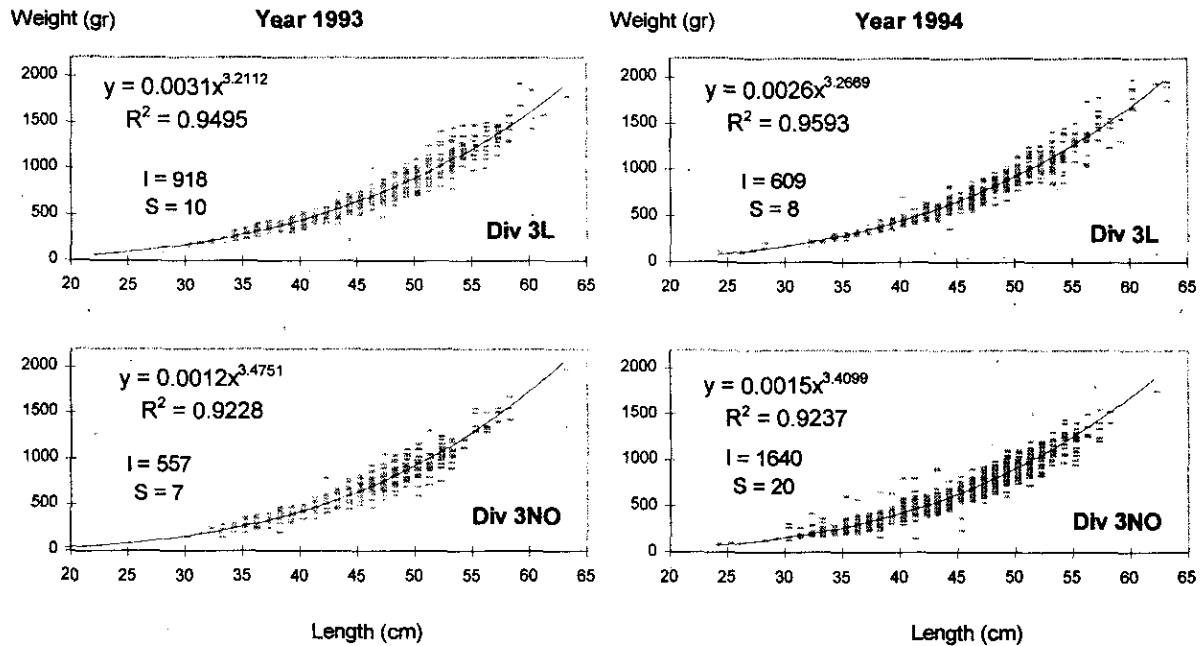
**Fig 7.-** Wich Flounder Sex-Ratio by NAFO Divisions and year. Spanish Greenland Halibut fishery. 1993 -1994, Large Vessels.



**Fig 8.-** Wich Flounder Sex-Ratio by NAFO Divisions and year. Spanish Greenland Halibut fishery. 1992 -1994, Small Vessels.



**Fig 9.- Sex Ratio (%) of Witch Flounder in NAFO Regulatory Area (Div 3NO). Spanish Bottom Trawl Survey. May 1995 and May 1996.**



**Fig 10. -Length / Weight relationship for witch flounder by year and NAFO Divisions 3L and 3NO. Spanish Greenland Halibut fishery (total fleet), 1993-1994. I = Individuals; S = Samples.**