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Distribution of American Plaice (*Hippoglossoides platessoides*) on the Grand Bank (NAFO Divisions 3NO), 1995-2004

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Abstract

The changes appreciated in the distribution of American plaice (*Hippoglossoides platessoides*) by depth on the Grand Bank (NAFO Divisons 3NO) in the period 2001-04 did not show a clear relationship with the increase of estimated biomass. Significant differences in the distribution depth range between sizes and sexes were observed. The females were distributed until deeper than the males. The small individuals (<20 cm) also appeared in the deepest strata. Inter-annual changes were appreciated in the period 2001-04 with an accused decrease in the distribution depth range in the 2004. The population was concentrated at shallower depth in spite of the increment of the abundance and biomass in the last year.

Introduction

The American plaice (*Hipoglossoides platessoides*, Fabricius) is an economically and ecologically important flatfish. American plaice or long rough dab (common name in Europe) is an arctic-boreal pleuronectid flatfish that inhabits both sides of the North Atlantic. In the eastern Atlantic, it is found from Iceland and Spitzbergen south to the North Sea, the western Baltic, and as far south as the English Channel. In the western Atlantic, it is common from the outer coast of Labrador, south from Hamilton Inlet, Newfoundland, on the Grand Banks, in the Gulf of St. Lawrence, west and south to Cape Cod. It occurs as far south as Montauk Point, NY (Johnson *et al*., 1999).

In the Northwest Atlantic, the highest densities generally occurred in the Grand Bank (Bowering and Brodie, 1991). In Div. 3LNO, American plaice is found in inshore areas in Div. 3L, in the shallowest areas of the Grand Bank, and at all depths including the slopes of the Bank, where they have been found in waters as depth as 1 400 m (Iglesias *et al*., 1994).

In the last years, the biomass and SSB in Div. 3L, 3N and 3O were very low compared with historical levels. SSB declined to the lowest level observed in 1994 and 1995. It has increased since then but still remains low (Brodie, 2002; Anon., 2004; Dwyer and Morgan, 2004; González Troncoso *et al*., 2004).

The effect in the distribution of this species in connection with its biomass level, the biomass of other predator or competitor species and the season/temperature has already been studied in different areas of its distribution area (Morgan and Brodie, 1991; Swain and Morin, 1996; Bowering *et al*., 1997; Swain, 1997; Swain *et al*., 1998; Swain and Morgan, 2001).

The aim of our paper is to analyze the distribution of American plaice as well as its possible inter-annual changes in connection with the biomass level, length and sex by depth. We examined and compared the length distribution changes in relation with depth, sex and size in the last years (2001-04) in Div. 3NO (NAFO). Biomass, abundance, annual length distribution and *sex ratio* in the period 1995-2004 also were revised.

Material and Methods

The study of the biomass and abundance, annual length frequency (‰) and *sex-ratio* of American plaice (*H. platessoides*) was carried out according to the results obtained in the bottom trawl Spanish Research Survey "Platuxa" in spring, from 1995 to 2004 (González Troncoso *et al*., 2004; and *pers. comm.*). The characteristics of the scientific surveys in this period are detailed in Table 1: vessel, gear, date, number of valid hauls, depth range (m), and number of samples and individuals sampled, size range (cm) and mode of American plaice.

The analysis by depth strata of the distribution and length frequency (‰), percentage of individuals by size ranges (<20 cm, 20-35 cm and ≥35 cm) and *sex-ratio*, was only carried out for the period 2001 to 2004, when the surveys were carried out in the *RV/ Vizconde de Eza*. We grouped the different strata and we gave a code, as shown in the following chart:

Depth Strata	Depth range (m)	Code
353-360-374-375-376	0-91	Str 1º
354-355-358-359-377-378-381-382	93-274	Str 2º
356-357-379-380-721-723-725	275-549	Str 3º
722-724-726-728-752-756-760-764	550-914	Str 4º
753-754-757-758-761-762-765-767	915-1463	Str 5º

Sizes samples of this species were carried out in all hauls with catch. The individuals were sexed and measured (TL to the nearest lower cm). The characteristics of the American plaice samples are shown in the Table 2: number of valid hauls, number of hauls with American plaice catch, number of samples, number of individuals sampled by sex, and size range (cm). The mean weight by individual in each stratum and year was calculated according to the estimated biomass and abundance; two samplings carried out in the two deepest strata in the year 2004 were not taken into account because there was an individual in each sampling. The sizes were grouped in six ranges to carry out the statistical analysis: 0-9, 10-19, 20-29, 30-39, 40-49, 50-59, ≥60 cm.

The study of feeding habits of American plaice, whose feeding intensity data is contributed here, was carried out by means of a stratified and random sampling by size range. The methodology was the same indicated in González *et al*. (2004).

To determinate if the size range, sex, depth strata and year had a significant effect on distribution, GLM Univariate procedure (General Linear Model) was used to test the hypothesis that the means of the frequency of this groups are not significantly different. In this variance analysis, the inter-group variance is divided in main effects and interactions. The main effects are the effects of each one of the independent variables, and the interactions are the crossings among the independent variables (Milton, 1994).

Results

Estimated Biomass and Abundance by depth strata (1995-2004)

The transformed indexes of biomass and abundance showed an increasing general trend along the series starting at very low levels from its beginning. The maximum was reached in the 2000, followed by a fall and new recovery starting in the 2003. The abundance in the year 2001 was high in relation to the biomass caused by a majority presence of individuals of small size (Fig. 1).

Most of the biomass and abundance estimated for the American plaice were at depths of 0-91 m (Str. 1º), it is approximately between 60 and 80% of the total of both indexes in the different years. This stratum is followed by the Str. 2º (93-274 m) with a distribution from 16 to 36% of the total. The biomass and abundance distributed in the remaining depth strata was a minimum part. In the year 1997, we found a different distribution from the one we have indicated previously. In this year, 40% and 10% of the total of the plaice was distributed respectively in the Str 1º and 2º, and we also find the biggest abundance and biomass in the Str. 5º (<915 m) of the series (Fig. 1).

With these results in the biomass and abundance estimated in the period 2001-04, there was a general tendency to increase the mean weight by individual with the depth, except in the 2004. The variations of this weight were accentuated in the 2002 (Fig 2).

Annual Distribution by Length (1995-2004)

An unimodal distribution was observed in the males from 1995 to 1999. The mode moved from 24-25 cm in 1995 (age 6) to 32-33 cm in 1999 (age 8-9). The distribution was bimodal in the years 2000-02, with high frequency of individuals <24 cm and low frequency of individuals of bigger size. In the last two years, the distribution tended to be unimodal again varying from 28-29 cm to 32-33 cm in the 2004 (Fig. 3).

In the females, the annual distribution of sizes was unimodal from 1995 to 1998. The mode changed from 24-25 cm (age 6) to 38-39 cm (age 10) in this period. Starting from 1999 the distribution was bimodal diminishing considerably the frequency of individuals with intermediate and big sizes until the first mode reached intermediate sizes (Fig. 4). The age data are indicative; we relate the modal sizes obtained here with the size-age results presented by Morgan *et al*. (2003).

Length Distribution by Depth Strata (2001-04)

The males in all their range of sizes were mainly distributed in the Str. 1º and 2º (0 - 274 m) in this period, and the females were distributed in a wider range of depth, mainly at depths between 93 and 914 m. A bigger distribution depth range was appreciated in the years 2002-03 in both sexes, and the contrary in the 2004, when plaice was found practically in the first three strata up to 549 m (Fig. 5).

Most individuals <20 cm were found in the Str. 1º and 2º (0-274 m), although they were also deeper than 900 m. A significant percentage of these sizes were found in 2004. Theses individuals were distributed at a greater depth in 2001-02, and concentrated in shallower water in 2004. The distribution into the deepest water of the smallest individuals is remarkable. The sampled individuals who were impossible to sex (undetermined) showed a size range between 5 and 16 cm, a mode in 9 cm and there were in high percentage at depths of 93- 274 m. Males <20 cm (6 to 19 cm and mode 19 cm) were distributed in a greater percentage in Str. 1º (0- 92 m). Females <20 cm (7 to 19 cm, mode 19 cm) were found in a greater percentage in Str. 1º and 2º (0-274 m), and they were in a greater percentage than males from this depth on. This behaviour recurred in bigger sizes (Table 3 and Fig 6).

Significant differences were found in the interactions among size range, sex and strata ($F_{(13,1280)} = 6.031$, $P \leq 0.000$), but not in the interaction of these three components with the year. However, if we consider only the main effect of the year, we do find significant differences ($F_{(3,1280)} = 1160.74$, $P \leq 0.000$) (Table 4).

Sex ratio

According to the series of the bottom trawl Spanish Research Survey from 1995 to 2004, the percentage of females was higher than the male one every year. The presence of undetermined individuals between 6 and 10 cm in the year 2004 is remarkable (Fig. 7). In the period 2001-04, both sexes were found at the same depths, but in a different percentage, and they also had similar annual dispersion behaviour. In Str. 1º (0-92 m) there was a higher percentage of males than females; the female percentage increased with depth in the following strata (Fig. 8).

Feeding intensity

The feeding intensity in the period 2002-04 increased slightly, and decreased with depth in all size ranges for both sexes except in some cases in 2004 (Table 5).

Discussion

Variations in temperature and oceanographic conditions have an influence on the abundance and distribution of marine organisms (Colbourne *et al.*, 2002). The average spring bottom temperature for the Div. 3LNO region shows large inter-annual variations. Physical oceanographic conditions experienced extreme variations in 1990s. Temperatures increased over the lows of early 1990s, in 1999 and 2000. During the spring from 2001 to 2003, the

average bottom temperature decreased below the 2000 value. In fact, temperature in 2003 was extreme in many areas, with temperatures below normal levels during the spring in southern areas of the Grand Bank (Colbourne *et al*., 2004).

Morgan (1992) reported a wide temperature tolerance by the American plaice. However, at the lowest temperatures they did not feed. Similar results were obtained comparing their feeding intensity in different distribution areas, and it turned out to be lower in colder seasons and areas. (González *et al*., 2003). It is possible that they shifted their distribution to greater depths to avoid long term exposure to such low temperatures (Bowering *et al.,* 1997). This specie showed a significant seasonal variation in the geographic distribution on the northern Grand Banks (Morgan and Brodie, 1991). And they also showed a tendency to occupy cold waters throughout the 1970s and most of the 1980s, however, changes in temperature distribution occurred toward warmer temperatures in the late 1980s and early 1990s on the Grand Bank, and this shift appears to be much stronger in spring than in fall (Swain and Morgan, 2001).

The distribution depth range of American plaice on the Grand Bank in spring runs from shallow water to depth deeper than 1 000 m (Iglesias *et al*., 1994). Our results show that the depth range containing more than 95% of abundance and biomass of American plaice in spring in the period 1995-2004 in Div. 3NO was at depths inferior to 300 m, and mainly <100 m. Except in 1997 when a very low biomass was detected (Fig. 1), there was an increase in the individuals with bigger size (Fig. 3 and 4) and it occurred within a period (1996-2000) when the presence of plaice in deeper strata was significant. (Fig. 1). However, this situation does not show a clear relation with observed temperatures (which have increased related to former years) in these area and period.

In our study, the estimated biomass of American plaice in the period 2001-04 increased its value; however, it did not expand its distribution depth, on the contrary, in 2004 with a greater biomass, American plaice was much more concentrated at shallower depth. The abundance in this period had a tendency to increase more than the biomass, the sex-ratio was close to 50% and the biggest sizes frequency decreased, which would show a major presence of that part of population which is preferably spread at shallower depth (small sizes and males). Swain and Morin (1996) in the study they carried out in the southern Gulf of St. Lawrence did not found a tendency to increase the geographic range (area containing 95% of the population) of American plaice when its abundance increased, or at least, the variation in American plaice abundance was insufficient to cause range expansion. However they noted that stock area tended to be greater for older plaice and for females. This fact was also reported in our study and other studies (Swain and Morgan, 2001). We have found a presence of both sexes throughout the whole distribution depth range, but male frequency decreased greatly from 275 m (Fig 5); from this depth on, medium and big size individuals were more in number, with the consequent increase of mean weigh of individuals in deeper strata (Fig. 2). However these size groups are also in shallower strata (Fig. 5). The inter-annual depth distribution changes found in the short period between years 2001-04 affected in a similar way to both sexes in the whole size range. Distribution was much wider in 2002, even for individuals of smaller size (<16 cm) found deeper than 1 000 m, and smaller in 2004, mainly limited to waters shallower than 550 m (Fig. 6, 7 and 8). This difference occurs in a period of low temperatures, and moreover, the survey was carried out a month later (in June) in the last year.

Sex-specific temperature distribution of American plaice has been reported. Females tended to occupy warmer water than males, and female temperature distribution was density-independent, but males tended to occupy colder water at higher levels of abundance (Swain, 1997). However, sex–specific temperature distribution of different populations is not homogenous concerning their density, sex and age (Swain and Morgan, 2001). In the Grand Bank, these authors have reported temperature associations of plaice in spring, with shifts in distribution toward warmer temperatures in the 1990s, coincident with the difference in temperature distribution between the sexes which has increased in recent years. They have also found a relationship between temperature distribution and density, and density-dependent effects on temperature preference are expected in relation to density-dependent food resources. Density-dependent temperature selection provides a possible explanation for the distribution. Seasonal variation in feeding has been reported for the distribution area of American plaice. The feeding intensity on the Grand Bank is great in spring and summer (Zamarro, 1992; González *et al.,* 2003). A significant increase in feeding intensity between April and June was even observed (data from the feeding and food study on the Grand Bank, 3NO, Spanish Survey Research "*Platuxa*" 02-04, *unpublished data*) (Table 5).

Walsh (1982) proposed that juvenile American plaice were concentrated in certain areas of the Grand Bank, often overlapping with adults distribution. In other subsequent study, Walsh *et al.* (1995) identified large geographic areas

on the Grand Bank where most of the young American plaice would be localized. However, this author (Walsh *et al.*, 2001) noted that there have been shifts in the spatial pattern of juvenile distribution on the Grand Bank during the 1990s. American plaice spawning in Div. 3LNO appeared to be widespread, without specific spawning locations identified, but in recent years spawning has occurred in deeper waters; these changes reflect the changes in stock distribution which began in the early 1990s (Morgan, 2001). In our study, indeterminate individuals <20 cm were not found in a greater percentage in the shallowest depths, which may be due to avoid predation, as it was noted that within this size range, and among individuals with the same size, females are located in a higher percentage at slightly greater depths than males, because the differences in growth between sexes are known (Fig. 5 and 6).

Other studies are necessary for a better understanding of the distribution of this species. Studies of maturation of plaice, predator and prey abundance and trophic relationship would contribute to a better knowledge of the behaviour and distribution pattern of American plaice.

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Table 1.- Characteristics of the bottom trawl Spanish Research Survey "*Platuxa*" 1995-2004 in Div. NO (NAFO).

CV/ or RV/	Year	Gear	Date	No. valid hauls	Depth range (m)	American plaice sampled			
						No. samples	No. individuals	Size range (cm)	Mode (cm)
Playa de Menduiña	1995	Pedreira	18/05 to 29/05	77	42 - 684	77	13275	12 - 71	24
Playa de Menduiña	1996	Pedreira	07/05 to 23/05	112	43 - 1066	100	16701	14 - 71	28
Playa de Menduiña	1997	Pedreira	26/04 to 17/05	128	42 - 1255	116	14029	14 - 68	30
Playa de Menduiña	1998	Pedreira	06/05 to 26/05	124	42 - 1355	108	12030	13 - 68	36
Playa de Menduiña	1999	Pedreira	07/05 to 26/05	114	41 - 1340	93	12287	10 - 77	32
Playa de Menduiña	2000	Pedreira	07/05 to 28/05	118	42 - 1401	96	11458	11 - 72	18
Vizconde de Eza	2001	*Campelen 1800*	05/05 to 23/05	92	36 - 1156	81	13016	5 - 70	20
Vizconde de Eza	2002	*Campelen 1800*	29/04 to 19/05	125	38 - 1540	108	13119	6 - 68	24
Vizconde de Eza	2003	*Campelen 1800*	11/05 to 02/06	118	38 - 1666	91	13464	6 - 66	28
Vizconde de Eza	2004	*Campelen 1800*	06/06 to 24/06	120	43 - 1460	75	13990	6 - 68	8, 9, 33

Table 2.- Characteristics of samples of American plaice by depth range in the bottom trawl Spanish Research Survey "*Platuxa*" 2001-04 in Div. 3NO (NAFO).

Year	Depth range (m)	No. valid hauls	No. hauls with A. plaice catch	No. samples	No. ind. sampled of A. plaice			Size range (cm)
					Males	Females	Indeterm.	
2001	0-91 (Str 1º)	38	38	38	3626	3231	87	6 - 70
	93-274 (Str 2º)	19	19	19	1123	2746	26	5 - 64
	275-549 (Str 3º)	11	11	11	173	1295	1	9 - 61
	550-914 (Str 4º)	11	11	11	73	633	0	16 - 69
	915-1463 (Str 5º)	4	2	2	1	1	0	24 - 38
2002	0-91 (Str 1º)	45	45	45	4317	3716	9	6 - 67
	93-274 (Str 2º)	23	23	23	1261	2362	0	8 - 61
	275-549 (Str 3º)	14	14	14	138	518	2	8 - 63
	550-914 (Str 4º)	16	11	12	91	461	0	12 - 68
	915-1463 (Str 5º)	16	12	12	30	142	1	8 - 50
2003	0-91 (Str 1º)	38	38	38	4295	2934	6	6 - 66
	93-274 (Str 2º)	25	25	25	1597	2840	2	6 - 65
	275-549 (Str 3º)	14	14	14	103	963	1	8 - 56
	550-914 (Str 4º)	16	11	11	41	416	0	16 - 57
	915-1463 (Str 5º)	15	1	1	2	25	0	17 - 53
2004	0-91 (Str 1º)	38	38	38	4234	4358	583	6 - 68
	93-274 (Str 2º)	25	25	25	830	3000	754	7 - 65
	275-549 (Str 3º)	13	8	8	12	198	16	7 - 58
	550-914 (Str 4º)	16	1	1	0	1	0	57 - 57
	915-1463 (Str 5º)	16	2	1	0	1	0	50 - 50

Table 3.- Percentage of American plaice by depth range, sex, size range (cm) and year in the bottom trawl Spanish Research Survey "*Platuxa*" 2001-04 in Div. 3NO (NAFO).

Percentage of individuals by size range, strata and year						
Size range (cm)	Sex	Depth Str.	Year 2001	2002	2003	2004
< 20 cm	Males	1º	8,37	2,47	3,36	2,03
		2º	2,19	2,49	1,84	0,50
		3º	0,16	0,08	0,03	
		4º	0,07	0,00	0,00	
		5º		0,02		
	Females	1º	6,38	2,94	2,17	1,40
		2º	4,50	3,62	2,24	0,67
		3º	0,47	0,09	0,08	0,00
		4º	0,29	0,01	0,01	
		5º		0,01	0,00	
	Indeterm	1º	0,64	0,06	0,05	6,28
		2º	0,18		0,03	9,35
		3º	0,00	0,01	0,00	0,03
		4º				
		5º		0,00		
20 - 35 cm	Males	1º	24,08	25,66	24,52	26,48
		2º	5,48	9,36	14,74	5,70
		3º	0,44	0,37	0,29	0,02
		4º	0,12	0,20	0,06	
		5º	0,00	0,05	0,00	
	Females	1º	14,81	19,58	11,58	19,58
		2º	7,60	16,12	21,63	12,39
		3º	2,53	1,46	4,78	0,30
		4º	0,86	0,67	0,43	
		5º		0,13	0,03	
> 35 cm	Males	1º	1,99	1,93	2,01	1,85
		2º	0,97	0,32	0,67	0,37
		3º	0,04	0,03	0,02	0,00
		4º	0,02	0,05	0,01	
		5º		0,02		
	Females	1º	9,18	8,52	5,82	9,32
		2º	6,26	2,53	2,88	3,69
		3º	1,74	0,34	0,43	0,03
		4º	0,62	0,61	0,27	0,00
		5º	0,00	0,26	0,02	0,00
Total			100	100	100	100

Table 4.- Results of GLM Univariate analysis of length frequency of American plaice of the bottom trawl Spanish Research Survey "*Platuxa*" 2001-04 in Div. 3NO (NAFO).

Tests of Between-Subjects Effects					
Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Corrected Model	1687078,41	178	9477,969	41,069	0,00000
Intercept	796424,96	1	796424,963	3450,998	0,00000
Size Range	50717,86	6	8452,977	36,628	0,00000
Sex	9493,13	1	9493,127	41,135	0,00000
Depth Strata	988174,59	4	247043,646	1070,468	0,00000
Year	803630,77	3	267876,924	1160,741	0,00000
Size range * Sex	4249,12	5	849,824	3,682	0,00259
Size range * Depth strata	16638,25	20	831,912	3,605	0,00000
Sex * Depth strata	15012,44	4	3753,111	16,263	0,00000
Size range * Sex * Depth strata	18093,78	13	1391,829	6,031	0,00000
Size range * Year	16953,90	18	941,884	4,081	0,00000
Sex * Year	210,43	3	70,142	0,304	0,82257 n.s.
Size range * Sex * Year	7379,56	12	614,963	2,665	0,00154
Depth strata * Year	1345383,97	11	122307,634	529,973	0,00000
Size range * Depth strata * Year	9548,75	44	217,017	0,940	0,58431 n.s.
Sex * Depth strata * Year	1218,14	9	135,349	0,586	0,80908 n.s.
Size range * Sex * Depth strata * Year	3924,86	23	170,646	0,739	0,80763 n.s.
Error	295399,74	1280	230,781		
Total	2217541,25	1459			
Corrected Total	1982478,15	1458			

Table 5.- Feeding intensity of American plaice by depth range in the bottom trawl Spanish Research Survey "*Platuxa*" 2002-04 in Div. 3NO (NAFO).

Year	Depth range (m)	Feeding intensity (%FI)																			
		Males								Females								Indeterm.			
		0-9	10-19	20-29	30-39	40-49	50-59	>= 60	Total	0-9	10-19	20-29	30-39	40-49	50-59	>= 60	Total	0-9	10-19	Total
2002	0-91 (Str 1º)		67	64	44	48			57	0	74	68	65	54	36	29	57			
	93-274 (Str 2º)	80	55	44	25	25			42	100	54	35	43	32	24	0	38			
	275-549 (Str 3º)		11	2	15				7		13	1	4	9	0	0	5			
	550-914 (Str 4º)		0	0	0	0	0		0		50	0	0	0	0	0	1			
	915-1463 (Str 5º)		0	33	14				21		25	21	0	0	0		7			
	Total	*80*	*54*	*44*	*32*	*41*			*43*	*67*	*58*	*34*	*36*	*33*	*29*	*24*	*37*			
2003	0-91 (Str 1º)	70	94	79	60	45			73	69	97	91	84	63	52	48	70	80		80
	93-274 (Str 2º)	77	76	52	46	50			60	60	78	50	52	54	42	30	54	67		67
	275-549 (Str 3º)		21	6	10	0			11		0	4	9	3	11		6			
	550-914 (Str 4º)			0	0				0		33	4	3	9	0		5			
	915-1463 (Str 5º)																			
	Total	*74*	*78*	*61*	*50*	*42*			*61*	*65*	*76*	*35*	*44*	*46*	*43*	*42*	*46*	*75*		*75*
2004	0-91 (Str 1º)	100	94	64	43	55			64	100	93	82	42	58	59	29	58	92	100	92
	93-274 (Str 2º)	0	97	50	40	100			78		95	88	56	93	100	100	88	88	100	90
	275-549 (Str 3º)											67					67	0	0	0
	550-914 (Str 4º)																			
	915-1463 (Str 5º)														100		100			
	Total	*86*	*95*	*63*	*42*	*58*			*67*	*100*	*94*	*82*	*46*	*66*	*64*	*31*	*68*	*87*	*92*	*87*

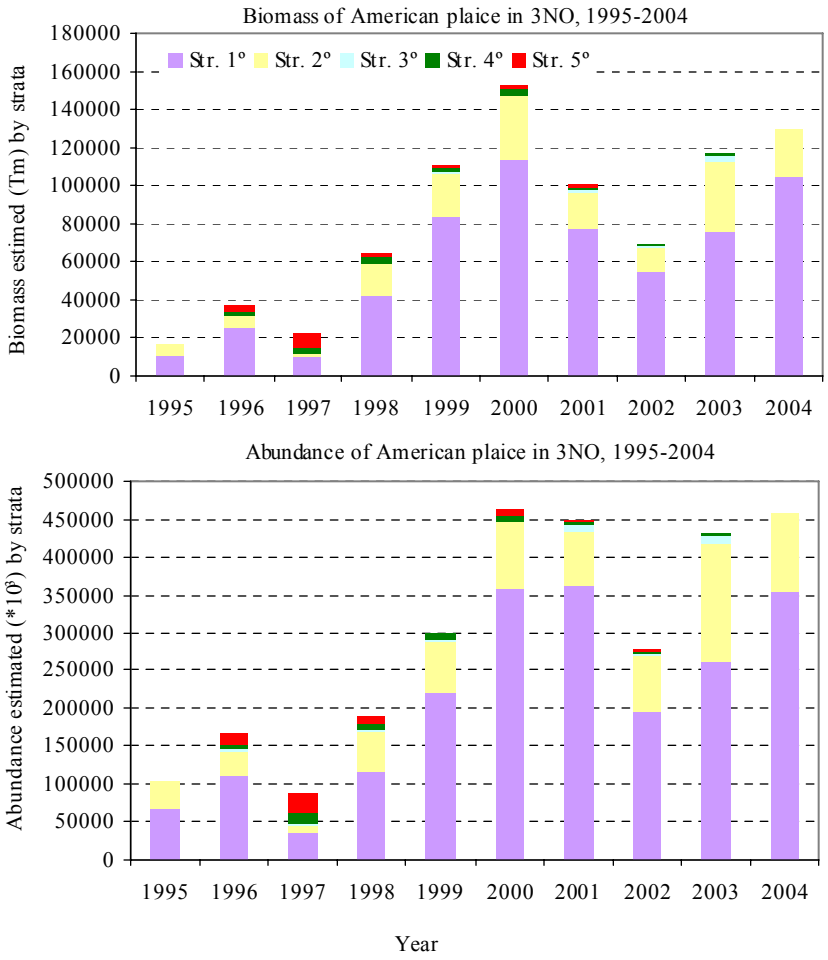

Fig. 1. Biomass and abundance estimated of American plaice by depth strata in 3NO, 1995-04 (Spanish Research Survey "*Platuxa*" 1995-2004, NAFO Div. 3NO).

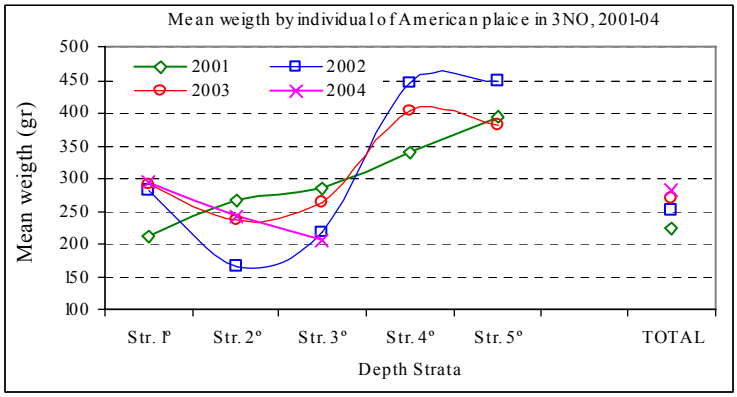

Fig. 2. Mean weight by individual of American plaice by depth strata in 3NO, 2001-04 (Spanish Research Survey "*Platuxa*" 2001-04, NAFO Div. 3NO).

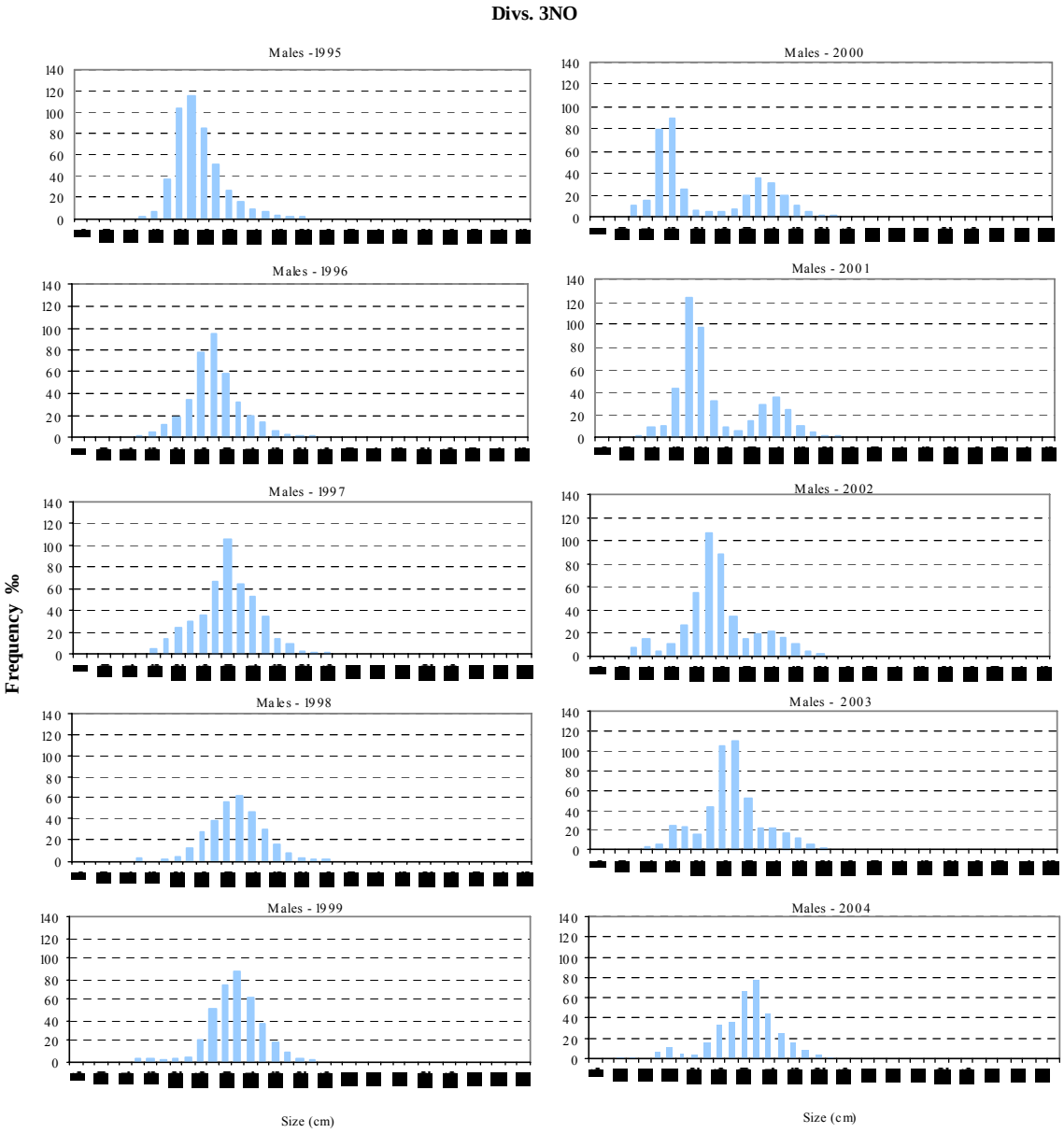

Fig. 3. Length distribution of American plaice males by year in 3NO, 1995-04 (Spanish Research Survey "*Platuxa*" 1995-04, NAFO Div. 3NO).

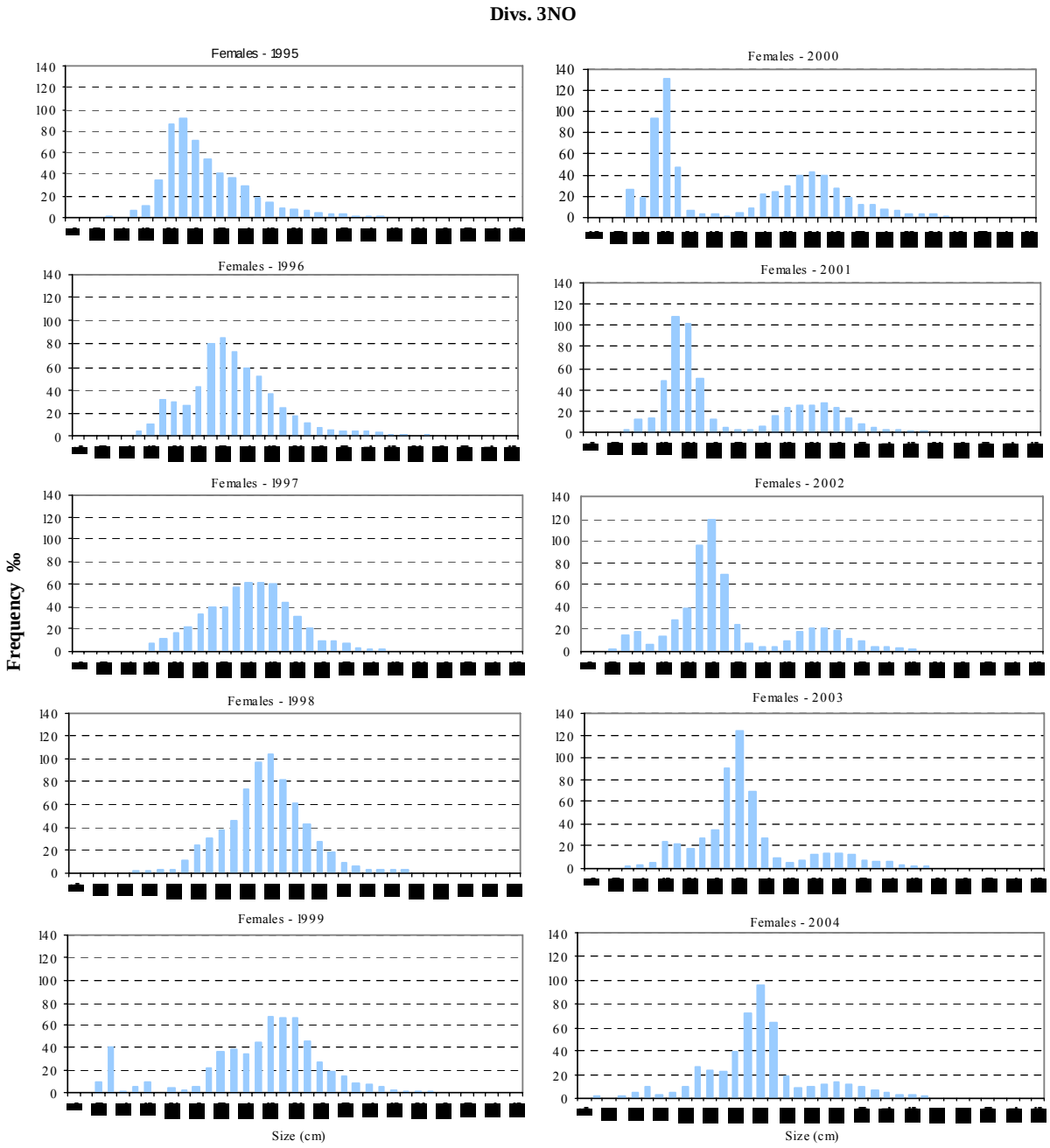

Fig. 4. Length distribution of American plaice females by year in 3NO, 1995-04 (Spanish Research Survey "*Platuxa*" 1995-04, NAFO Div. 3NO).

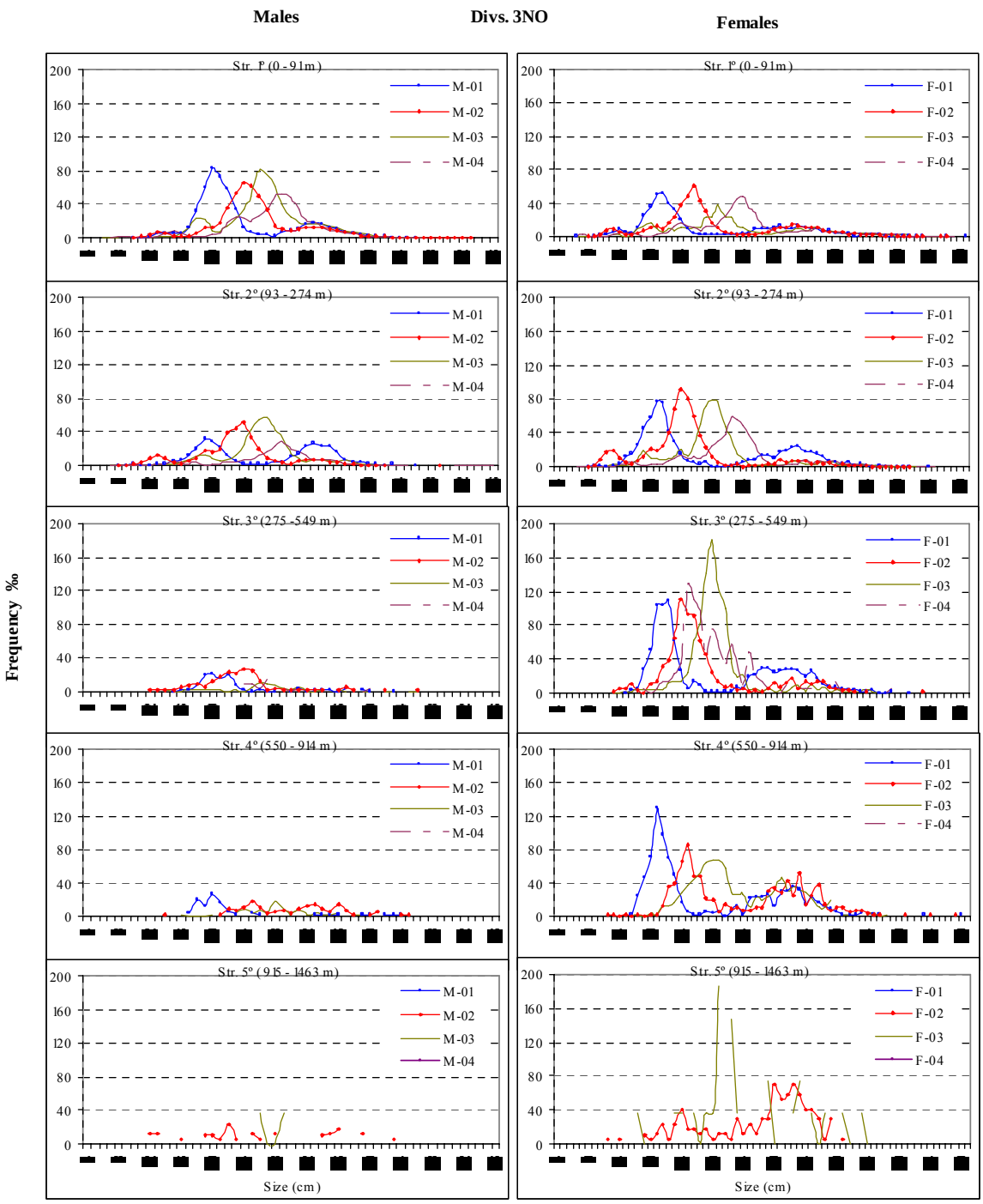

Fig. 5. Length distribution of American plaice males and females by detph strata and year in 3NO, 2001-04 (Spanish Research Survey "*Platuxa*" 2001-04, NAFO Div. 3NO).

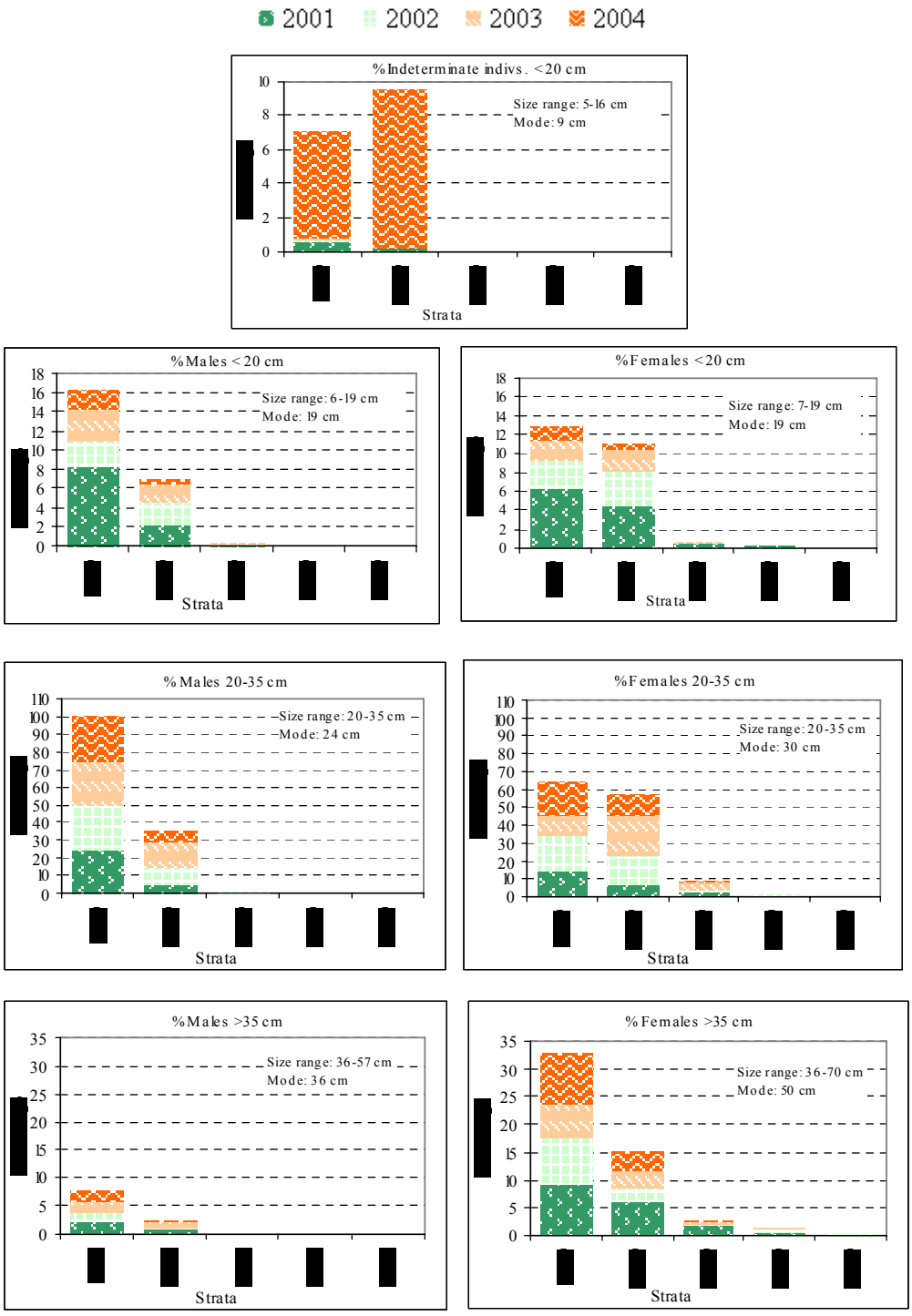

Fig. 6. Percentage of individuals of American plaice by group size, depth strata and year in 3NO, 2001-04 (Spanish Research Survey "*Platuxa*" 01-04, NAFO Div. 3NO).

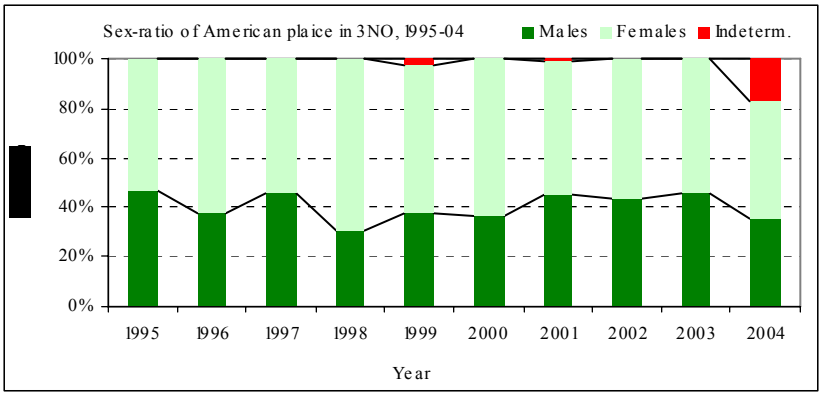

Fig. 7. *Sex-ratio* of American plaice in 3NO, 1995-2004 (Spanish Research Survey "*Platuxa*" 1995-04, NAFO Div. 3NO).

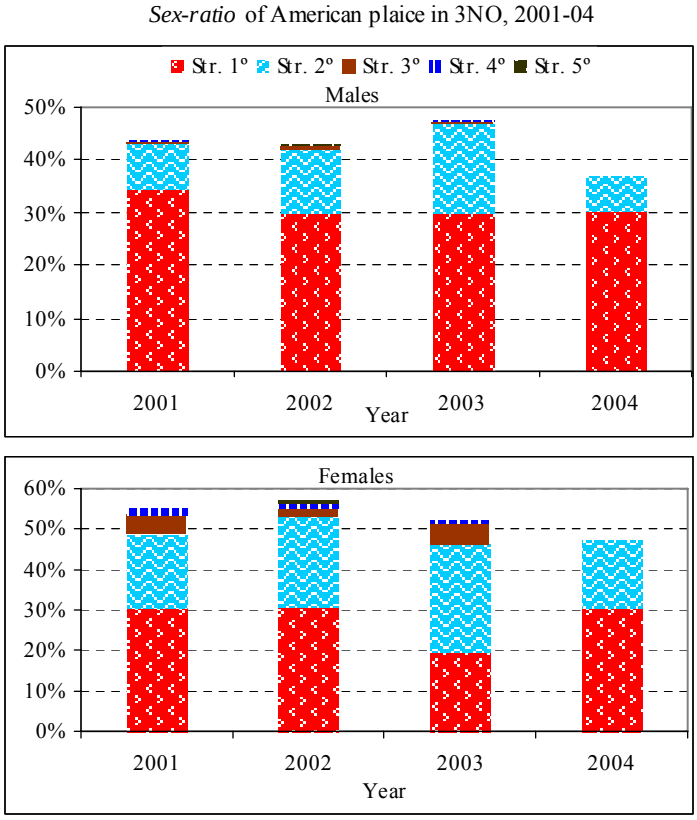

Fig. 8. *Sex-ratio* of American plaice by depth strata and year in 3NO, 2001-04 (Spanish Research Survey "*Platuxa*" 2001-04, NAFO Div. 3NO).