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Yellowtail Flounder Length at Maturity in the Grand Bank (1995-98).

by

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ABSTRACT

In this paper yellowtail length at maturity estimates based data collected in the spring Spanish surveys in the Regulatory Area of Divisions 3NO are presented. Female length at 50 % maturity decreased from 35 cm in 1995 to 23 cm in 1998. In males, this parameter decreased from 23 cm in 1995 to 19 cm in 1998. The differences in L_{50} estimates in females were significant between 1997 and the previous years , and between 1998 and both 1996 and 1995, and were not significant between 1997 and 1998. In males, differences were significant between all the years, except between 1997 and 1998. The covariance analysis between the linearized maturity curves were highly significant in both sexes.

***KEYWORDS*:** Yellowtail flounder, maturity curves, length at maturity, males and females.

INTRODUCTION

The yellowtail flounder is an spring-early summer spawner species (Zamarro 1988). In past this stock had a northern distribution limit in commercial concentrations off Newfoundland coast, but at present it is concentrated on the Grand Bank, mainly in the southern part, where the juvenile and the adult components overlap in their distribution (Walsh 1992, Brodie et al. 1998). There was a fishing moratoria for this stock from 1994 to 1997, and for 1998 the Scientific Council recommended reopening a limited fishery, stating also that this fishery should be carefully monitored and sampled.

Morgan and Walsh (1977) presented estimates of length and age at maturity for yellowtail flounder in Divisions 3 LNO from 1975 to 1995, based on the Canadian spring survey. They observed a declined in males length at maturity, but no decline was evident in females. Durán et al. (1998) presented estimates of the length at maturity based on the Spanish spring survey in the Regulatory Area, where the decline was observed in both sexes. Variations in length at maturity can be caused by several factors: growth variability, geographic distribution and stock abundance. Besides random natural variability can occur, though under stable population conditions this should be small (Walsh and Morgan 1998).

In this paper additional data from the spring Spanish survey in Divisions 3NO on this subject is examined, in order to determine the consistency of the declining trends observed in previous years.

MATERIAL AND METHODS

Yellowtail maturity data used in this study have been collected during the Spanish spring surveys conducted in the Regulatory Area in Div. 3NO from 1995 to 1998 (Paz et al. 1996 and 1997; Durán et al. 1998). The geographic distribution of the yellowtail samples analysed in the successive surveys appear in Fig. 1, and the length ranges and numbers in Table 1. Fish were classified as mature or immature by visual examination of the gonads. A simple four-point scale was used to do it, where the first stage is designed as immature and all the others (maturing, spawning and post-spawning) as matures.

The proportion of mature males and female by size were adjusted to a logistic equation as described by Ashton (1972) :

$$\bar{P} = \frac{e^{a+bL}}{1+e^{a+bL}}$$

and the logit transformation:

$$\ln\frac{\bar{P}}{1-\bar{P}} = a + bL$$

where $\bar{P}$ is the predicted mature proportion, *a* and *b* the coefficients estimated of the logistic equation and *L* the length. The size at maturity can be estimated as the minus ratio of the coefficients (- *a* / *b*) by substituting $\bar{P}$ = 0.5 in the above equation.

To evaluate the differences in size at maturity between years, the variance of those parameters every year was calculated from the variances and covariance of the maturity curve coefficients (Ashton, 1972):

$$V(L_{50}) = \frac{1}{b^2}\left[V(a) + \frac{a^2}{b^2}V(b) - \frac{2a}{b}\operatorname{cov}(a,b)\right]$$

Assuming that L_{50} estimates are normally distributed, then the Z statistic can be computed as:

$$Z = \frac{\frac{a_1}{b_1} - \frac{a_2}{b_2}}{\sqrt{V_1 + V_2}}$$

where *a* and *b* are the logistic regression coefficients and V_1 *and* V_2 the L_{50} variances of every year compared. Z values can be used to test the null hypothesis of parameters equality (Gunderson, 1977). The linear transformation of the maturity curves are also compared using a covariance analyses to evaluate between years differences in the curve slopes and the influence of the length distributions on the length at maturity estimates.

All the statistical analysis have been performed using the Statistica package (StatSoft. Inc., 1995).

RESULTS AND DISCUSSION

The length range is approximately similar in the three years analysed (table 1), but since 1997 the proportion of the smaller length classes increased in the samples. This is reflecting a parallel decrease of the yellowtail lengths caught in the survey (Paz et al. 1997).

The maturity curves for females and males are shown in Fig. 2, and the parameters of the fitted curves in Table 2. Female length at 50 % maturity slightly decreased from 1995 (35 cm) to 1996 (34 cm), but a pronounced decrease is observed in 1997 (24 cm), maintained in 1998 (23 cm) . In males L_{50} ranges from 23 cm in 1995 to 27 cm in 1996, and then decrease to 21 cm in 1997 and 19 cm in 1998. The differences in L_{50} estimates in females were significant between 1997 and the previous years (1996 and 1995), and between 1998 and both 1996 and 1995, and were not significant between 1997 and 1998 (table 3). In males, differences were significant between all the years, except between 1997 and 1998 (table 3).

The covariance analyses of the maturity curves (Table 4) indicate that the slopes and intercepts are significantly different between years in both sexes. Thus, the mature proportions at length are different in the years analysed, not only due to a difference in the length distributions involved. Also the rate of increase of the mature proportions with length is different.

Decreases in both age and length at maturity in coincidence with decreases in stock abundance has been observed in recent years in several shelf species from this same area (Stearns et al. 1984; Morgan et al. 1993; Saborido and Junquera 1998). However it is difficult to assert that such could be the case of the yellowtail flounder, as the stock seems to be at present in a better situation than it was in the past (Anon. 1997). From Morgan and Walsh (1997) results, including a much longer time series (1975 – 95), few trends were evident , though a decline in males L_{50} since 1984 occurred from 30 cm to 25 cm at the end of their time series. The L_{50} estimates in the only coincident year with the present study (1995) are approximately similar in both sexes, but in contrast , Morgan and Walsh (1997) found a more pronounced decreasing trend on males L_{50} while we found it in females.

The present study are based in a series of surveys which cover only partially the yellowtail flounder distribution range, namely the part of the stock in the Regulatory Area. The length at maturity results obtained in 1997 are consistent with the 1998 estimates, and can be reflecting a change in the species distribution pattern. In 1997 and 1998 mainly small fish appeared in the survey area (Paz et al. 1997, Durán et al. 1998) and they were largely more concentrated than in previous surveys. Thus mature small fish, likely first spawners, became more available to the surveys in 1997-1998 just because of a change in their distribution, or those small adults became more abundant because they belong to a large year class.

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Table 1.- Numbers of yellowtail flounder sampled by length, sex and year in the spring Spanish survey in Div. 3NO.

	FEMALES				MALES			
LENGTH	**1995**	**1996**	**1997**	**1998**	**1995**	**1996**	**1997**	**1998**
>14			2	6		2	1	2
14-16	12		18	9	8	16	12	4
17-19	37	42	42	51	8	55	38	50
20-22	22	61	87	90	14	82	85	79
23-25	28	103	100	82	26	53	91	75
26-28	20	48	118	53	22	64	109	70
29-31	34	55	150	69	34	74	80	84
32-34	66	71	112	68	33	60	66	56
35-37	46	123	121	59	33	20	60	45
38-40	39	119	116	74	17	9	34	38
41-43	24	51	91	79	3	1	10	19
44-46	12	42	23	41			4	5
47-49	5	14	4	11			1	
50-52	3	2	1					
53-55		5	1					
total	348	736	986	692	198	436	591	527

Table 2.- Parameters of the yellowtail flounder females (F) and males (M) maturity curve in Div. 3NO (1995 – 98). ‘a’ and ‘b’ = coefficients of the adjusted logistic curve; St. Error = standard error of the estimates; L_{50} = length at 50 % maturity; Var. exp.= variance explained by the model; N = numbers sampled.

	FEMALES							
	1995		1996		1997		1998	
	a	b	a	b	a	b	a	b
Estimate	-12.98	0.37	-15.65	0.46	-13.08	0.55	-10.98	0.48
St. error	1.50	0.04	1.34	0.03	0.85	0.03	1.34	0.06
L50	**35 cm**		**34 cm**		**24 cm**		**23 cm**	
Var. exp.	54 %		62 %		64 %		62 %	
N	348		736		986		692	
	MALES							
	a	b	a	b	a	b	a	b
Estimate	-6.65	0.29	14.06	0.50	-12.45	0.59	-9.63	0.51
St. error	1.41	0.06	1.27	0.04	1.46	0.07	1.38	0.02
L50	**23 cm**		**27 cm**		**21 cm**		**19 cm**	
Var. exp.	35 %		64 %		50 %		40 %	
N	198		436		591		527	

Table 3.- Z values of the comparative analysis of the yellowtail flounder length at maturity between years. * significance (p<0.05); ** significance (p<0.01); otherwise not significant.

Z - FEM.	**1996**	**1997**	**1998**
1995	0.55	5.18**	14.1**
1996		8.53**	16.8**
1997			0.65
Z – MALES	**1996**	**1997**	**1998**
1995	2.99**	2.15*	1.78*
1996		4.36*	5.26**
1997			0.41

Table 4. Covariance analysis between years (1995 – 98) of the mature proportions at length (effect) in 3NO yellowtail flounder.

	F E M A L E S				
	SS	**df**	**MS**	**F**	**P - level**
Effect	26.16	44	0.59	16.46	0.0000
Error	3.09	122	0.04		
	M A L E S				
	SS	**df**	**MS**	**F**	**P - level**
Effect	17.12	38	0.45	12.84	0.0000
Error	2.07	93	0.03		

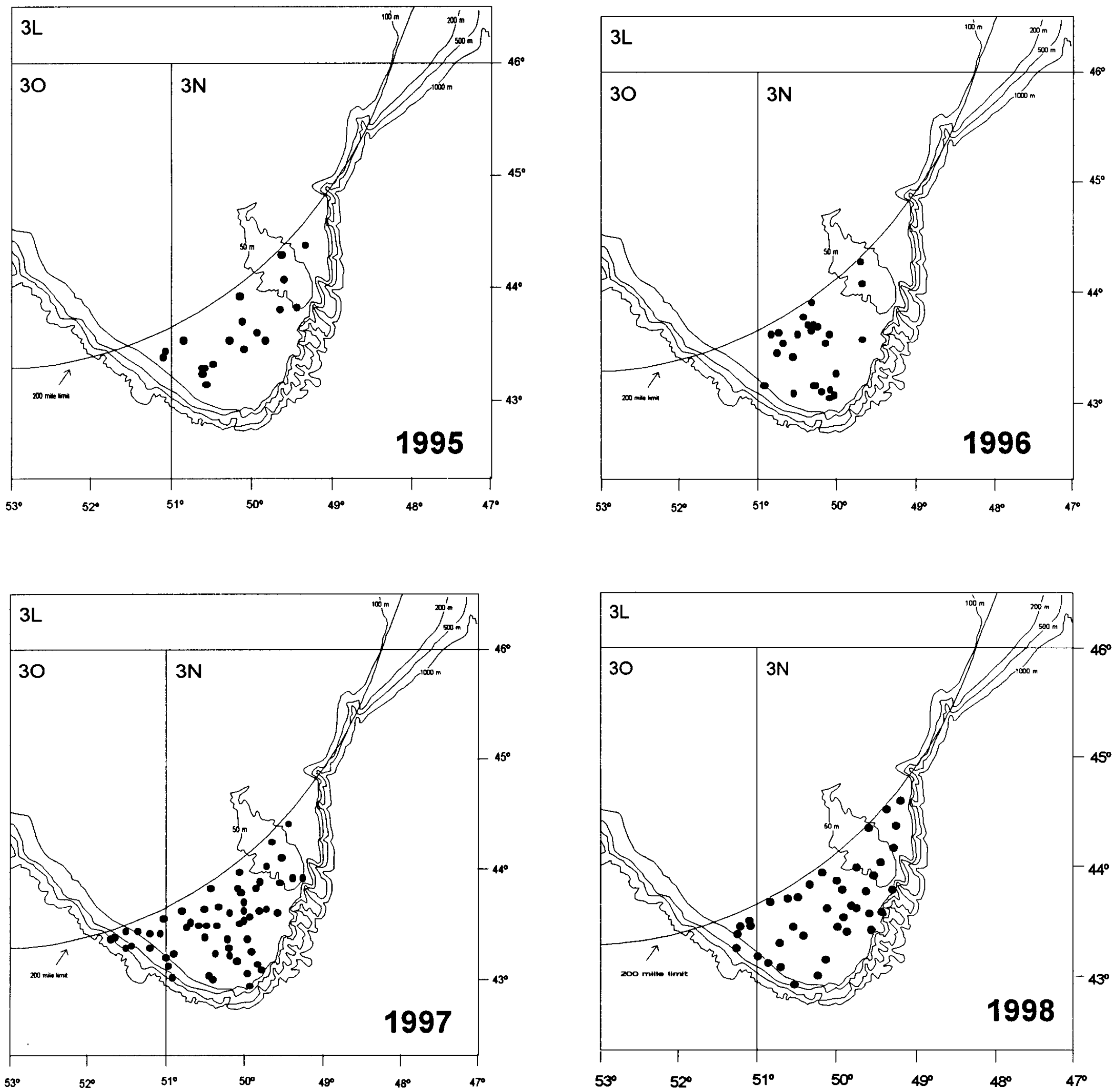

Fig 1.- Yellowtail flounder sampling area in the Spanish spring bottom trawl surveys in Div. 3NO (1995-1998).

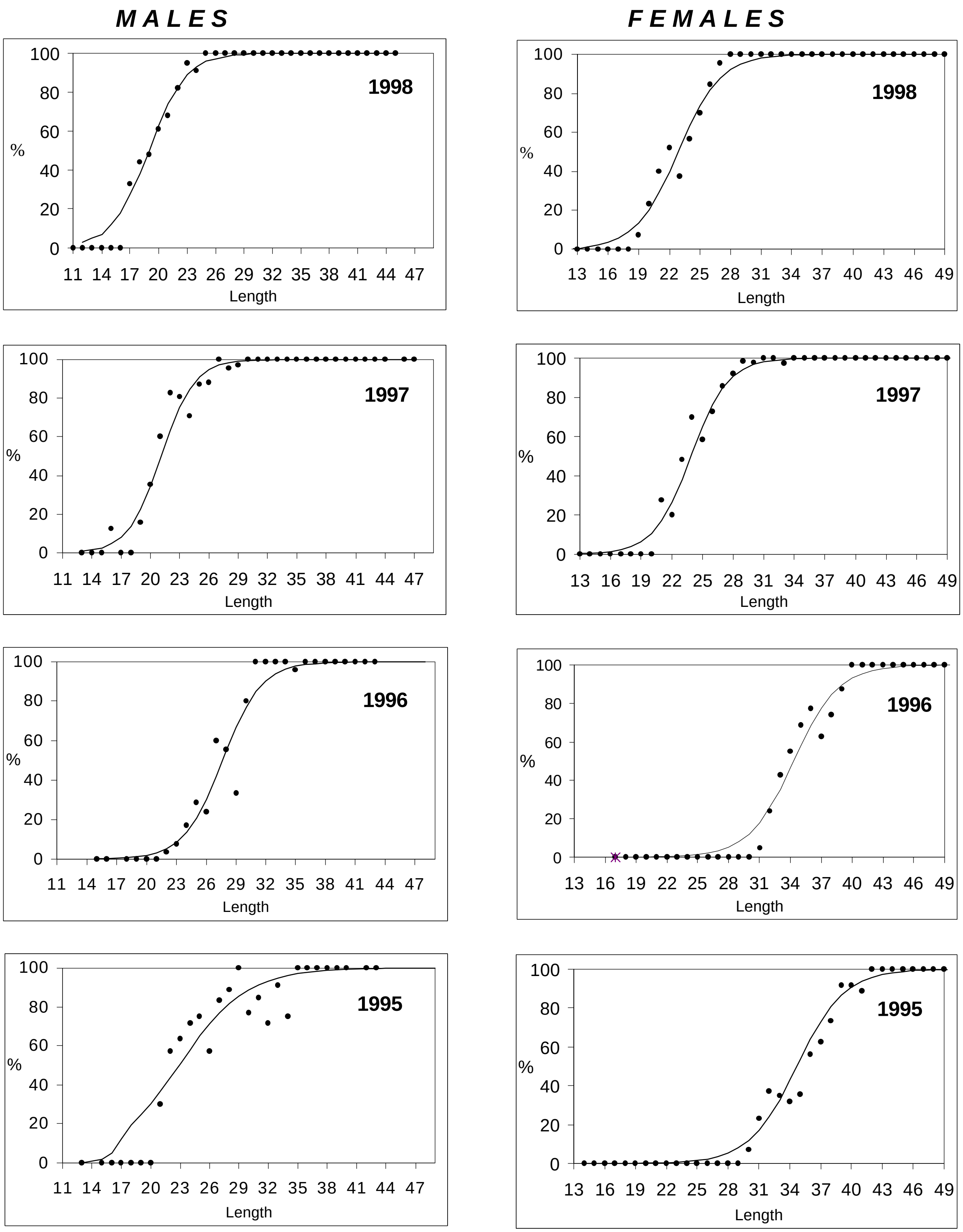

Fig. 2.- Yellowtail flounder maturity curves by sexes in Div. 3NO (1995-98).