NOT TO BE CITED WITHOUT PRIOR REFERENCE TO THE AUTHOR(S)

Northwest Atlantic Fisheries Organization

Serial No. N3012

NAFO SCR Doc. 98/27

SCIENTIFIC COUNCIL MEETING - JUNE 1998

Observations of Length at Maturity in Yellowtail Flounder on the Grand Bank (1995-97)

by

P. Durán, S. Junquera and J. Paz

Instituto Español de Oceanografia, Apdo. 1552, Vigo, Spain

INTRODUCTION

Length and age at maturity are essential information to determine the spawning stock biomass and stock-recruit relationship. The usual knife-edge estimates of the mature proportions in fish populations obscure the knowledge on the true levels of the spawning potential of the stocks and the temporal variability is ignored.

The yellowtail flounder stock is mainly concentrated on the southern Grand Bank, where the juvenile and the adult components overlap in their distribution. 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. In this paper additional information on this subject is presented, based on the results of the of the Spanish spring survey in Divisions 3NO.

MATERIAL AND METHODS

Yellowtail maturity data used in this study have been collected during the Spanish spring surveys conducted in Div. 3NO from 1995 to 1997 (Paz et al. 1996 and 1997). The geographic distribution of the yellowtail samples analysed appears in Fig. 1, and their 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) :

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

and the logit transformation:

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

where $\hat{P}$ 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 $\hat{P}$ = 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):

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

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

In table 1 can be observed that although the length range is approximately similar in the three years analysed, in 1997 samples the smaller lengths are more abundant in both sexes. 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 by length 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). In males L_{50} ranges from 23 cm in 1995 to 27 cm in 1996, and then decrease to 21 cm in 1997. The difference in L_{50} estimates between years is significant only between 1996 and 1997 in females, but significant differences occurred in males among the three years compared (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 three 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 low stock abundance has been observed in recent years in several species (Stearns et al. 1984; Morgan et al. 1993; Saborido and Junquera 1998), but 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 decrease in female L_{50} seems to us too drastic and specially too sudden to be easily explainable. This results are based in a series of surveys which only partially cover the yellowtail flounder distribution range, and then any change in the species distribution pattern is expected to affect the parameter estimates. In 1997 mainly small fish appeared in the survey area (Paz et al. 1997) and they were largely more concentrated than in previous surveys. Probably mature small (likely first spawners) fish were found by the first time in the survey area in 1996 and 1997 because of a change of their distribution, or those small adults became more abundant because they belong to a large year class which is coming. A longer time series is required to determine weather the observed decrease in L_{50} persists or if it is in the context of the general variability that this species shows in this parameter, as already was pointed by Morgan and Walsh (1997).

REFERENCES

Anon. (1997).- Report of Scientific Council NAFO SCS Document,

Ashton, W. D. (1972).- The logit transformation with special reference to its uses in bioassay. Hafner Publishing Co., Inc., New York, 88 pp.

Gunderson, D. R. (1977).- Population Biology of Pacific Ocean Perch, Sebastes alutus, stocks in the Washington-Queen Charlotte sound region, and their response to fishing. Fishery Bulletin, 75 (2): 369-403.

Morgan, M. J. , Bishop, C. A., Baird, J. W. (1993).- Temporal and spatial variation in age and length at maturity in 2J3KL cod. NAFO SCR Doc. 93/57.

Morgan, M. J. and S. J. Walsh (1977).- Observations on maturation, recruitment and spawning stock biomass in yellowtail flounder on the Grand Bank. NAFO SCR Doc. 97/71.

Paz, X., P. Durán and E. de Cárdenas (1996).- Preliminary results from the 1996 Spanish bottom trawl survey in the NAFO Regulatory Area for Divisions 3NO. *NAFO SCR Doc*. 96/**49**.

" (1997).- Preliminary results from the 1997 Spanish bottom trawl survey in the NAFO Regulatory Area for Divisions 3NO. *NAFO SCR Doc*. 97/**25**.

Saborido, F. and S. Junquera (1998).- Histological assessment of the variations in sexual maturity of cod (Gadus morhua L.) in Flemish Cap (Northwest Atlantic). ICES J. Mar. Science (in press).

StatSoft Inc. (1995).- STATISTICA for Windows [Computer program manual]. Tulsa, OK.

Stearns, S. C., and Crandall, R. E. (1984).- Plasticity for age and size at sexual maturity: A life-history response to unavoidable stress. In: Fish Reproduction. Strategies and Tactics. Edited by G. W. Potts and R.J. Wootton. Academisc Press, London. pp. 13-33.

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

LENGTH	FEMALES			MALES		
	1995	1996	1997	1995	1996	1997
<14	0	0	2	0	0	1
14-16	12	0	18	8	2	12
17-19	37	42	42	8	16	38
20-22	22	61	87	14	55	85
23-25	28	103	100	26	82	91
26-28	20	48	118	22	53	109
29-31	34	55	150	34	64	80
32-34	66	71	112	33	74	66
35-37	46	123	121	33	60	60
38-40	39	119	116	17	20	34
41-43	24	51	91	3	9	10
44-46	12	42	23	0	1	4
47-49	5	14	4	0	0	1
50-52	3	2	1	0	0	0
53-55	0	5	1	0	0	0
Total	348	736	986	198	436	591

Table 2.- Parameters of the yellowtail flounder females (F) and males (M) maturity curve in Div. 3NO (1995 – 97). '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.

	1995				1996				1997			
	F		M		F		M		F		M	
	a	b	a	b	a	b	a	b	a	b	a	b
Estimate	-12.98	0.37	-6.65	0.29	-15.65	0.46	14.06	0.50	-13.08	0.55	-12.45	0.59
St. error	1.50	0.04	1.41	0.06	1.34	0.03	1.27	0.04	0.85	0.03	1.46	0.07
L_{50}	**35 cm**		**23 cm**		**34 cm**		**27 cm**		**24 cm**		**21 cm**	
Var.exp.	54 %		35 %		62 %		64 %		64 %		50 %	
N	348		198		736		436		986		580	

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.

	FEMALES	
YEAR	1996	1997
1995	0.55	5.18**
1996		8.53**
	MALES	
YEAR	1996	1997
1995	2.99**	2.15*
1996		4.36**

Table 4. Covariance analysis between years (1995 – 97) of the mature proportions by length (effect) in 3NO yellowtail flounder.

			FEMALES		
	SS	**df**	**MS**	**F**	**P - level**
Effect	20.83	42	0.49	13.62	< 0.0000
Error	3.09	85	0.03		
			MALES		
	SS	**df**	**MS**	**F**	**P - level**
Effect	13.62	33	0.41	11.36	< 0.0000
Error	2.07	57	0.03		

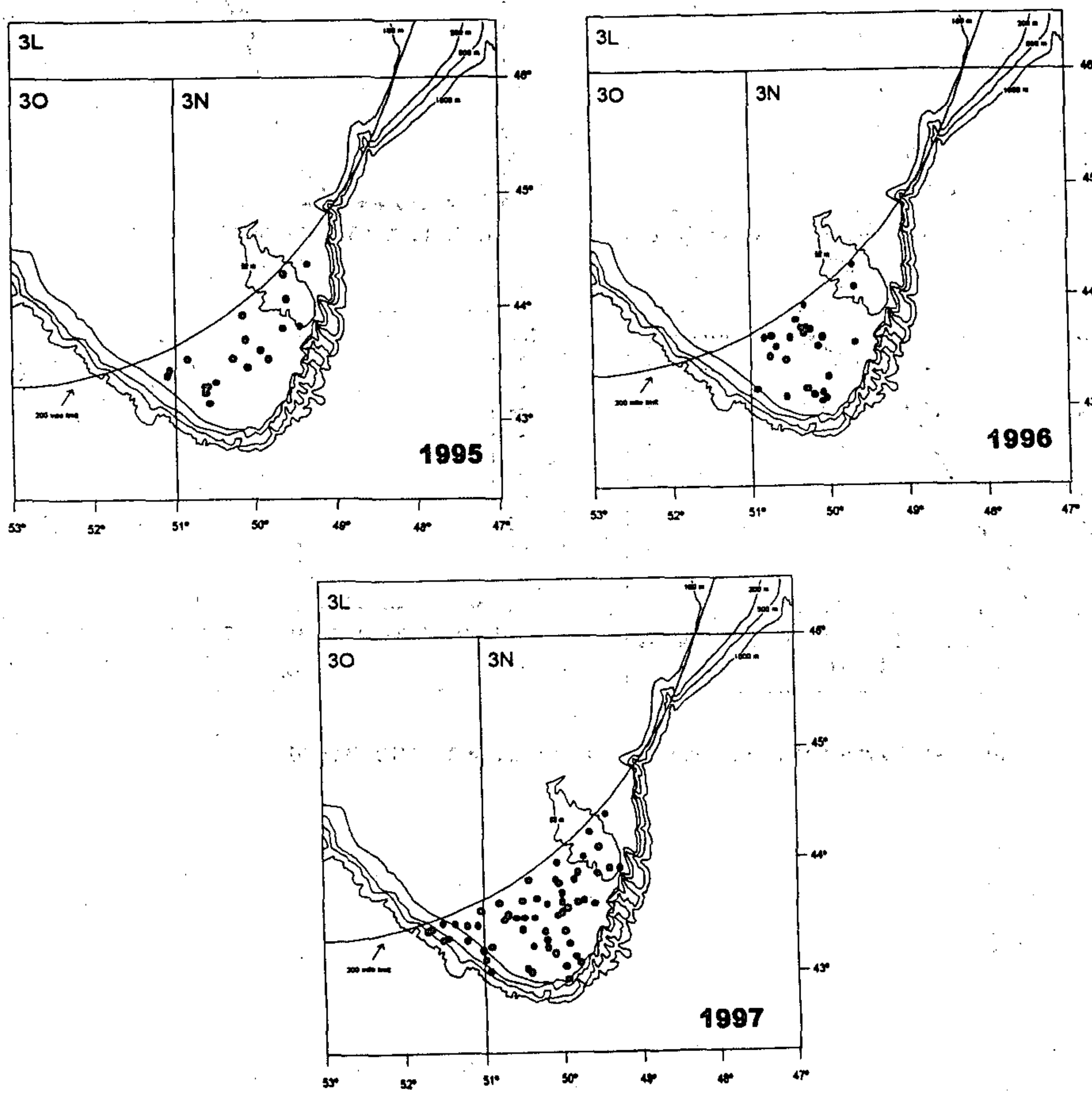

Fig 1.- Map of NAFO Divs. 3NO, showing the location of the samples. Spanish 3NO bottom trawl survey 1995-97.

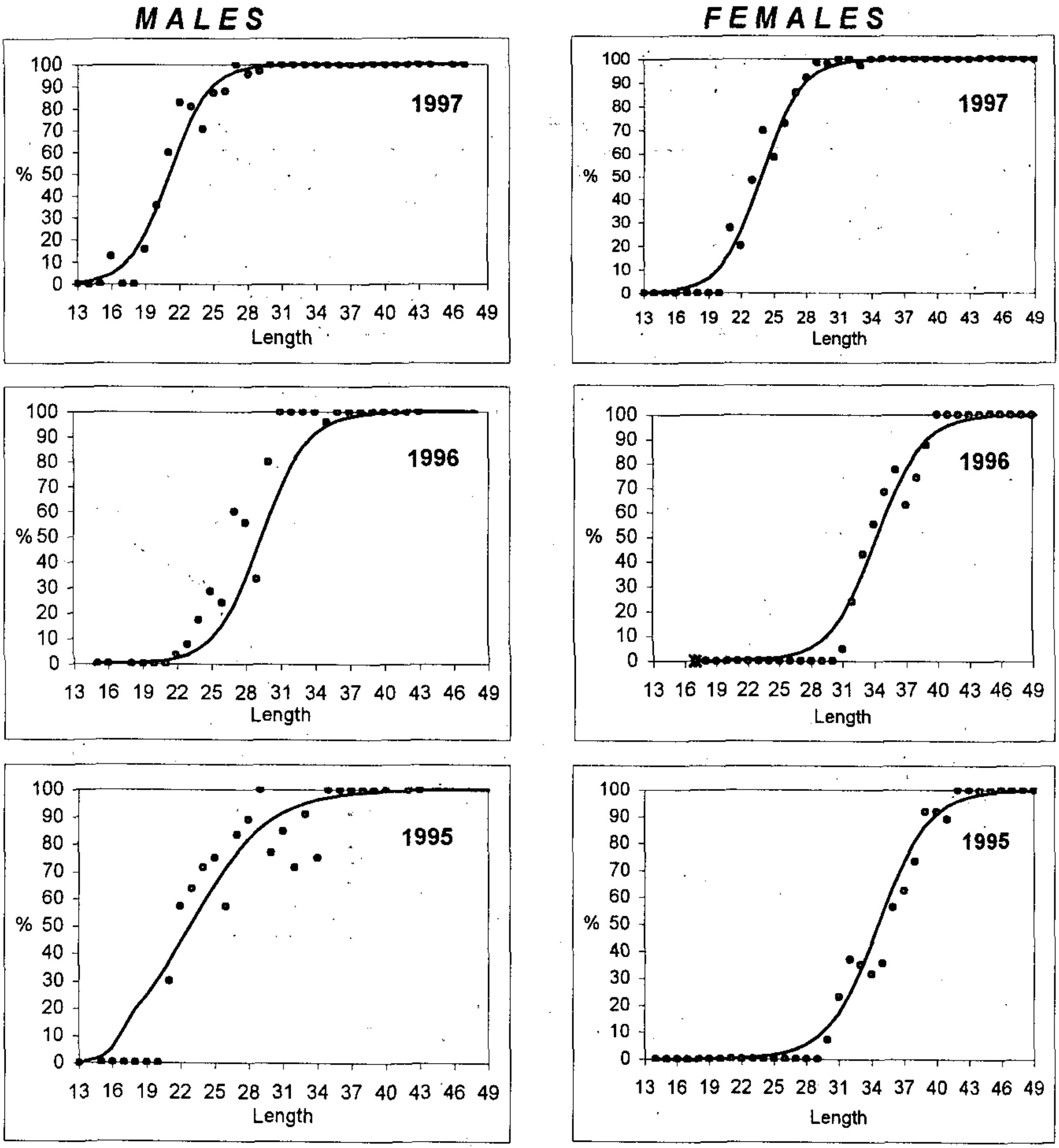

Fig. 2.- Yellowtail flounder maturity curves by sexes in Div. 3NO (1995-97).