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On Cod Stocks in NAFO Waters

by

A. Vazquez
Instituto de Investigaciones Pesqueras
Bouzas, Vigo, Spain

Introduction

The three main cod stocks in the NAFO Area - 2J+3KL, 3NO and 3M - have usually been studied independently. This paper is an overview of these three stocks that, as a starting point, present one similar feature - the low catches after 1968.

Methods

All of the information on ICNAF Statistical Bulletins for the 1954-78 period was processed. The method described by Vazquez and Larrañeta (1980) was used for calculating actch-per-unit-effort (CPUE) values for each year and stock.

Two different analyses were carried out. In the first case, each stocks was studied independently. Fishing power factors for each vessel category and for each stock were calculated from the catches in each stock, and CPUE factors for each year, and other factors, were calculated from the fishing power factors. In the second case, the fishing power factors were calculated from all catches in the three stocks, by assuming that fishing power is independent of the stock (i.e. we calculate a stock-independent fishing power), but again, for each stock, CPUE factors and other factors were calculated, as in the first case, but using these new fishing power factors. The results were quite similar in both cases, and so we use the results of the second one.

For estimating equilibrium points of the relationship between CPUE and effort, annual efforts for each stock were weighted after the Fox (1975) method, using as the maximum factor two different values: 8.5 and 5.0. In this paper, if no reference is made, factor 5.0 is the one used. There was no substantial difference between the results with the two factors, for the purpose of this paper.

Results

CPUE values were properly correlated with particular stock estimations of other authors as follows:

Stock	r^2	Reference
2J+3KL	0.97	Gavaris (1980)
3NO	0.94	Bishop and Gavaris (1981)
3M*	0.78	Gavaris (1981)

* When using data for 3M only, $r^2 = 0.89$

CPUE values for 1979 and 1980 in Div. 2J+3kl and 3NO were deduced from the data of these authors, but we were afraid to do so for Div. 3M. Effort values were poorly correlated with F values from VPA analysis (r^2 less than 0.20).

Fig. 1 shows the relationship between CPUE and effort and equilibrium yield and effort for the cod stocks in Div. 2J+3KL, 3NO and 3M. Numerical data are given in Table 1.

Discussion

From Fig. 1, it is difficult to see a linear relationship between CPUE and effort for Div. 2J+3KL and 3NO, and the calculation of such regressions makes little biological sense. It must be remembered that these points are equilibrium estimations and not annual points. With annual efforts, a circuling distribution of CPUE-effort points would be expected when effort increases and decreases consecutively, but there is no population dynamics theory to explain this distribution of equilibrium approximations.

It seems that the three sets of data show coincident development. The CPUE was high up to 1968, declined during 1969-73, and was maintained at a lower level after 1973. If this parallelism exists and if it is not acceptable that in Div. 2J+3KL and 3NO the same regression line cross the 1963-68 points and the 1972-76 points simulataneously, this will not be acceptable for Div. 3M also, although for this stock the points seem distributed around the same line. In other words, there are also two different levels in Div. 3M but the points are grouped.

According to this pattern scheme, some observations can be made. In the Div. 2J+3KL and 3NO stocks, the high fishing effort in the late 1960's could be understood as the cause for the decline from a high level of CPUE to a lower one, but in the Div. 3M stock the decline occurred at a low level of effort. The same fact was interpreted in Div. 3NO in the years 1957-58 (Vazquez and Larraneta, 1980). After the decline from a high level to a low level of CPUE, the effort decreased in Div. 2J+3KL and 3NO cod stocks but it increased in the Div. 3M stock, and the CPUE values were maintained at about the same low level in the three stocks. All of these features seem to indicate an independence between the change in the different levels of CPUE and the effort.

It seems clear that the equilibrium situation for these stocks are far from the equilibrium stages assumed by the generalized production models, as that of Schaefer, but we are not devoted to think that such a situation is a non-equilibrated or erratic condition because nature is always in equilibrium. Larraneta (1981) gives an explanation for the two levels of CPUE in Div. 3NO and 3M. This would result from a change in the stock-recruitment relationship.

Referring to the Div. 2J+3KL cod stock (Fig. 1) it is not difficult to draw a straight line with a negative regression coefficient, as the Schaefer model assumes, for the upper points. A negative regression coefficient is not evident for a line fitted to the lower points. The tendency of 1979 and 1980 points, if correct, would indicate a recovery of the fishery to the upper level of CPUE.

Conclusions

For the cod stocks of Div. 2J+3KL, 3NO and 3M, the relationship between CPUE and effort does not correspond to a linear dependance, as the Schaefer model assumes. In fact, two different equilibrium situations can be discerned. Historically, the decline from a high to a lower level of CPUE does not correspond with high fishing effort and vice versa.

For the Div. 3NO and 2J+3KL stocks, effort is actually at a low level, as compared with the last 25 years, and there is no evidence that, by maintaining this effort level, the fishery would be improved (i.e. increase to a higher CPUE level). In Div. 2J+3KL, this increase could have happened if the provisional data for 1979 and 1980 are correct.

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Table 1. Cod catches and efforts.

year	2J+3KL				3NO				3M			
	catch	cpue	effort	$\bar{F}$	catch	cpue	effort	$\bar{F}$	catch	cpue	effort	$\bar{F}$
1954	304.007	1.00	304.007		133.141	1.00	133.141			1.00		
55	263.918	.90	293.242		113.007	.89	126.974			1.18		
56	300.535	1.08	278.273		64.880	1.21	53.620			.58		
57	275.733	1.08	255.308		85.575	1.11	77.095			1.03		
58	217.045	.82	264.689	271.332	45.974	.63	72.975	81.414		.58		
59	329.572	.93	354.378	296.424	62.465	.79	79.070	76.850		.82		
1960	458.799	1.00	458.799	352.964	79.677	.82	97.167	81.923	17.152	1.36	12.612	
61	498.078	.99	503.109	413.237	72.724	.89	81.712	83.832	22.996	1.69	13.607	
62	502.752	1.06	474.294	448.917	34.984	.84	41.648	70.514	16.175	1.07	15.117	
63	499.904	1.05	476.099	470.598	69.742	1.50	46.495	61.174	38.216	1.74	21.963	
64	603.585	1.00	603.585	520.681	64.461	1.17	55.095	56.466	47.819	1.34	35.686	23.430
65	555.654	.86	646.109	568.325	99.187	1.30	76.298	60.424	60.313	1.27	47.491	32.662
66	522.307	.88	593.531	585.956	108.919	1.13	96.388	72.470	33.834	1.26	26.852	32.688
67	610.535	.93	656.489	618.544	226.784	1.27	178.570	110.932	42.163	1.33	31.702	33.448
68	807.470	.93	868.247	709.572	165.512	1.20	137.927	126.718	40.385	1.19	33.937	33.848
69	748.433	.76	984.780	813.302	117.705	1.04	113.178	128.159	31.845	1.36	23.415	29.942
1970	516.213	.66	782.141	824.072	111.561	.96	116.209	126.738	26.529	.83	31.963	29.703
71	432.496	.57	758.765	817.981	126.296	1.03	122.617	124.792	33.692	.74	45.530	35.022
72	458.170	.52	881.096	841.651	103.374	.69	149.817	130.164	57.691	.68	88.840	52.198
73	354.509	.47	754.274	808.074	80.429	.52	154.671	139.071	22.900	.50	45.800	52.819
74	372.649	.51	730.684	774.232	73.389	.50	146.778	144.231	24.941	.66	37.789	49.979
75	287.508	.49	586.751	709.351	44.124	.53	83.347	126.007	22.375	.66	34.423	45.059
76	214.220	.45	476.044	620.595	24.283	.75	32.377	92.984	22.266	.62	35.913	40.471
77	172.720	.32	539.750	571.921	17.604	.39	45.138	70.231	27.239	.54	50.443	41.368
78	138.559	.35	395.883	498.049	14.718	.28	52.564	56.932	33.131	.43	77.049	53.426
79	160.000	.52	305.191	417.838	28.049	.90	31.028	43.261				
1980	180.000	.93	192.998	328.596	18.542	.52	35.658	38.850				

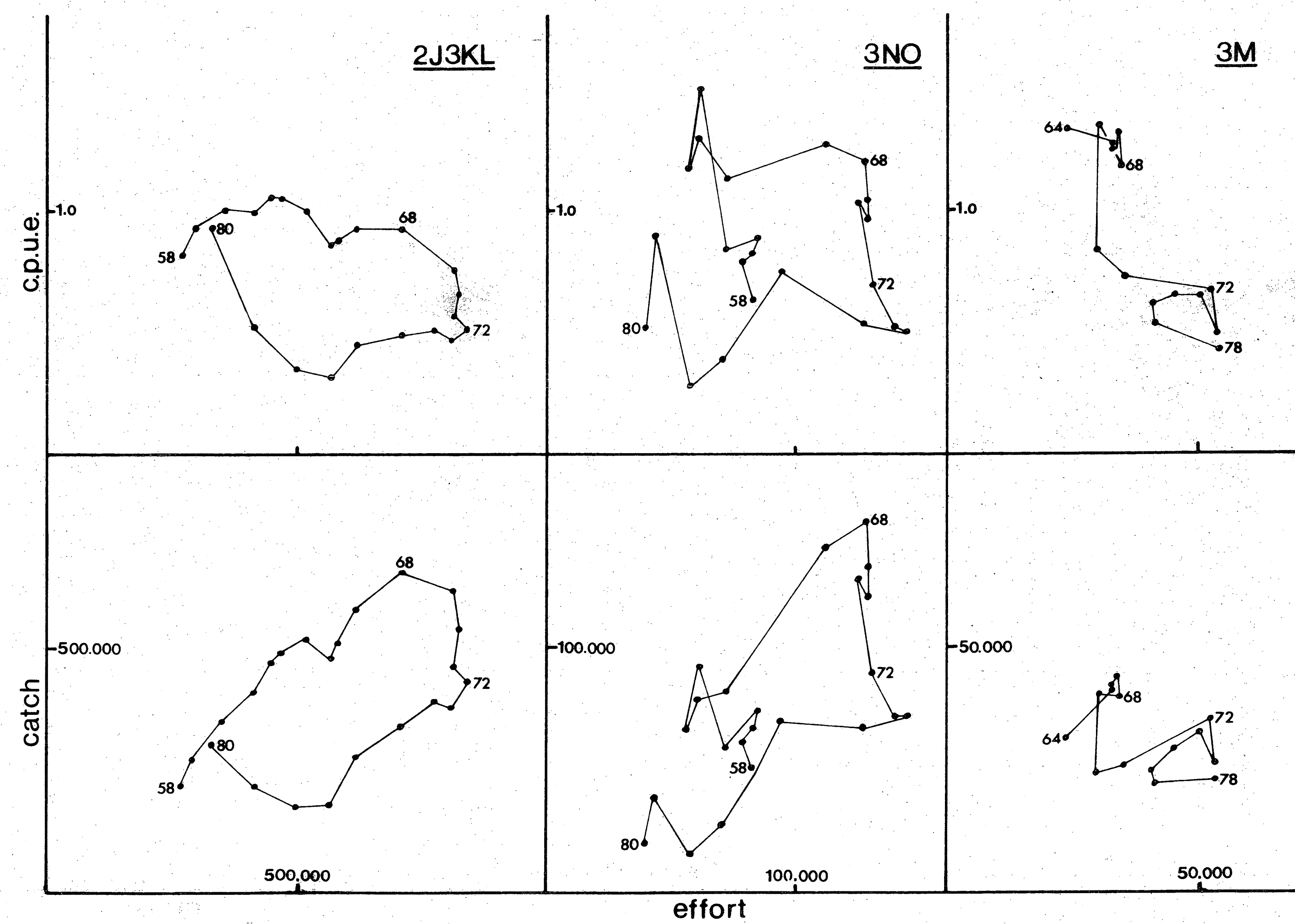

FIGURE 1 - C.p.u.e.-effort and catch-effort relationships on cod stocks