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Assessment of the cod stock in NAFO Divisions 2J + 3KL

by

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INTRODUCTION

A catch rate series for 1959-80 was obtained and subsequently used to perform a surplus production analysis. The method used was similar to that described by Gavaris (1980). Catch and effort data for 1959-77 was derived from ICNAF statistical Bulletins. Data for 1978 was preliminary information supplied by the NAFO Secretariat. FLASH reports were used for 1979. It was necessary to convert days fished to hours fished for the FLASH reports. The factors used for conversion are shown in Table 1. Catch and effort data for Newfoundland vessels was available for 1979 and 1980. In all cases the catch and effort was used only if cod was specified as main species in the record.

RESULTS

Several country-gear types and all months, divisions and years were used in the analysis. The regression coefficient for the country-gears, months, and division are presented in Table 2. After examining these results some of these categories were grouped as shown in Table 2 and the regression was performed again. Each point in the regression was weighted according to $(\text{CATCH} \times \text{EFFORT})^{0.25}$. The results of this regression are summarized in Table 2. Based on the F values, inclusion of each of the category types in the model significantly reduced the variation in the data.

The estimates of mean catch rate and its standard error are presented in Table 3 along with total catch, proportion of the catch which was used in the regression and standardized effort. The standards used were CanM OT-5 + Port OT-6 for country-gears, March & May for months and Div. 3L. Approximate 90% confidence intervals for the mean are given in Fig. 1. The most evident feature is the decline from high catch rates in the 60's to low catch rates in the 70's. An upward trend is indicated for 1979 and 1980.

The fit of this data to the surplus production model can be assessed by examining Fig. 2. The largest differences occur in 1968, 1969, 1977, 1978 and 1980. It should be noted that the 1980 catch rate had a large variance. The biomass trend in Fig. 3 is essentially a smoothed, scaled version of the catch rate series. This figure indicates that if effort was maintained at the levels occurring during 1964-75 then the stock would, after many years, tend to extinction. The equilibrium yield curves are presented in Fig. 4 and 5. Figure 4 shows that when yield was greater than the equilibrium value for that biomass level, i.e. above the curve, the biomass declined. In Fig. 5, it can be seen that while the effort was large i.e. to the right of the curve, the yield generally declined.

The management implications of this analysis follow. The average maximum sustainable yield is 638,000 t and the average sustainable yield at 2/3 the effort at MSY is 525,000 t. The stock at present is not in equilibrium. The predicted non-equilibrium yield in order to maintain effort at 2/3 the MSY level is 141,000 t resulting in a catch rate of 0.98 t/hr. This is close to the observed rate for 1979. If in fact the stock has improved substantially as indicated by the 1980 catch rate then this catch would be conservative. However, the 1980 data is only preliminary. A "safe" optimistic prediction for catch in 1981 would be 218,000 t, obtained by using the lower 90% confidence bound of catch rate for 1980 and the effort at 2/3 the MSY level.

REFERENCES

Gavaris, S. 1980. Assessment of the cod stock in Division 3M. NAFO SER Doc. 80/II/25, Ser. No. N057.

Table 1. Conversion factors for days fished to hours fished

<u>Country-gear</u>	<u>Subarea</u>	<u>hrs/day</u>
Port OT-6(side)	2	13.32
	3	18.61
Port OT-6(stern)	2	18.29
	3	15.85
Port OT-7	2	16.39
	3	16.63
Span OT-6	2	12.05
	3	14.33
Span PT-4	2+3	13.83
Span PT-5	2+3	14.93
UK OT-6	2	18.95
	3	16.15
USSR OT-7	2	7.60
	3	12.35

Table 2. Regression coefficients before and after grouping and analysis of variance from the regression of the ln catch rate.

<u>Country-gear</u>	<u>ln Power</u>	<u>ln Power</u>	<u>Month</u>	<u>ln Power</u>	<u>ln Power</u>
Span PT-6	1.104	1.098	Feb	0.089	0.112
Port OT-7	0.797		Jan	0.000	
Span PT-5	0.777	0.792	Apr	-0.030	0.000
Span PT-4	0.540	0.537	Mar	-0.145	
			May	-0.195	-0.151
Port OT-6	0.464				
CanM OT-5	0.420	0.463	Jun	-0.336	-0.312
Span OT-6	0.336	0.335	Dec	-0.402	-0.378
USSR OT-7	0.257	0.259	Jul	-0.547	-0.523
CanN OT-5	0.100	0.098	Nov	-0.619	
			Aug	-0.622	-0.597
Icel OT-5	0.004				
CanM OT-4	0.000	0.000	Sep	-0.666	
			Oct	-0.708	-0.663
UK OT-6	-0.141	-0.143			
USSR OT-6	-0.229	-0.226	Div.		
CanN OT-4	-0.271				
USSR OT-5	-0.310	-0.291	2J	0.000	0.000
			3K	-0.191	-0.190
			3L	-0.312	-0.312

Table 2. Continued

REGRESSION OF MULTIPLICATIVE MODEL

MULTIPLE R..... 0.742
 MULTIPLE R SQUARED..... 0.551

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SUMS OF SQUARES	MEAN SQUARES	F-VALUE
TYPE 1	10	1.51601E2	1.51601E1	76.995
TYPE 2	7	1.72916E2	2.47023E1	125.458
TYPE 3	2	3.76083E1	1.88041E1	95.502
TYPE 4	21	2.90635E2	1.38397E1	70.289
REGRESSION	40	6.35197E2	1.58799E1	80.651
RESIDUALS	2627	5.17247E2	1.96896E-1	
TOTAL	2667	1.15244E3		

Table 3. Historical catch and estimated catch rate and effort. The proportion of the catch used for estimation is indicated.

YEAR	CATCH	PROP.	CATCH RATE		EFFORT
			MEAN	STD ERR	
1959	329572	0.250	1.769	0.111	186304
1960	393577	0.301	1.791	0.096	219752
1961	498078	0.305	1.831	0.095	272025
1962	502752	0.480	1.920	0.088	261850
1963	499904	0.489	2.015	0.090	248091
1964	603585	0.377	1.937	0.084	311608
1965	555654	0.439	1.650	0.069	336760
1966	522307	0.391	1.792	0.076	291465
1967	610535	0.415	1.846	0.073	330734
1968	807470	0.322	1.861	0.076	433890
1969	748433	0.302	1.577	0.064	474592
1970	516213	0.337	1.388	0.059	371911
1971	432496	0.382	1.160	0.048	372841
1972	458170	0.266	1.035	0.044	442676
1973	354509	0.323	0.923	0.041	384083
1974	372650	0.362	1.036	0.048	359700
1975	287508	0.278	0.933	0.045	307824
1976	214220	0.204	0.893	0.053	239619
1977	172630	0.230	0.543	0.027	317918
1978	139000	0.197	0.479	0.027	290187
1979	160000	0.254	0.998	0.063	160320
1980	180000	0.151	1.808	0.196	99557

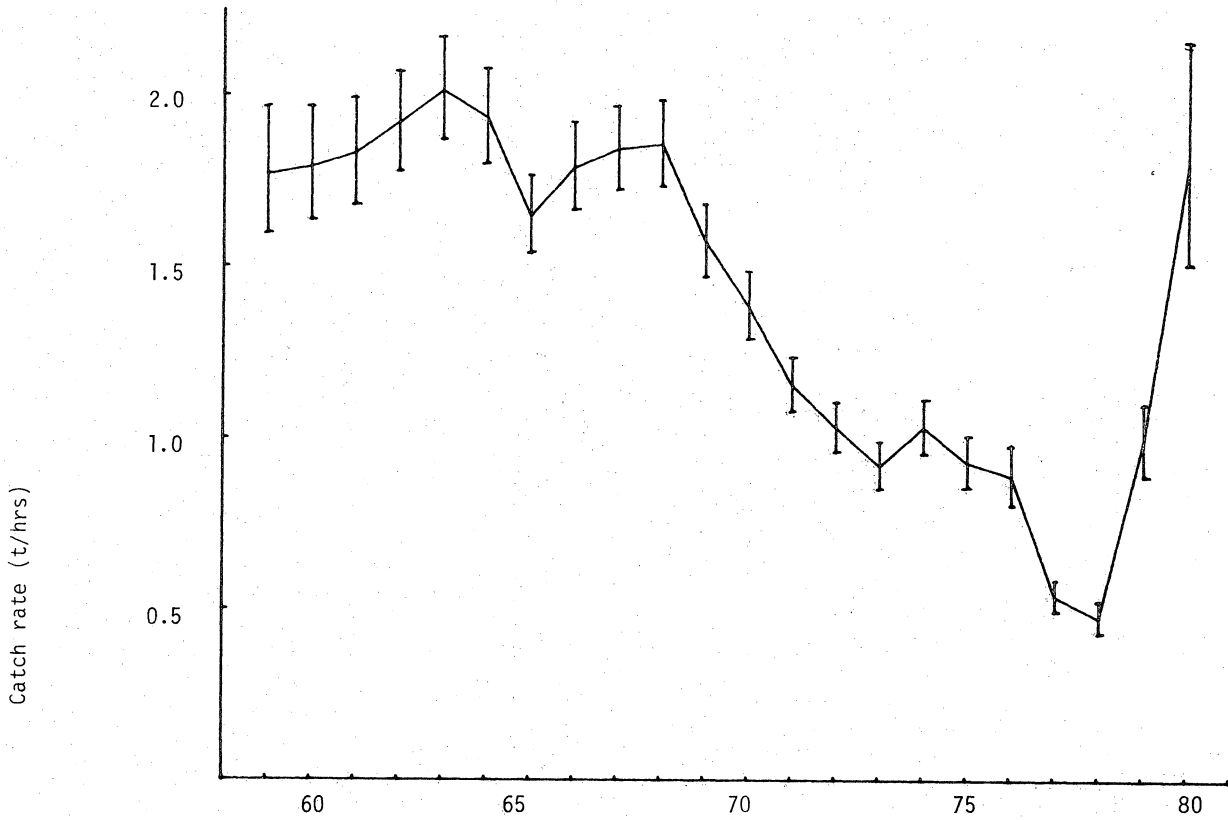


Fig. 1. Standardized catch rates for cod in NAFO divisions 2J+3KL with approximate 90% confidence intervals

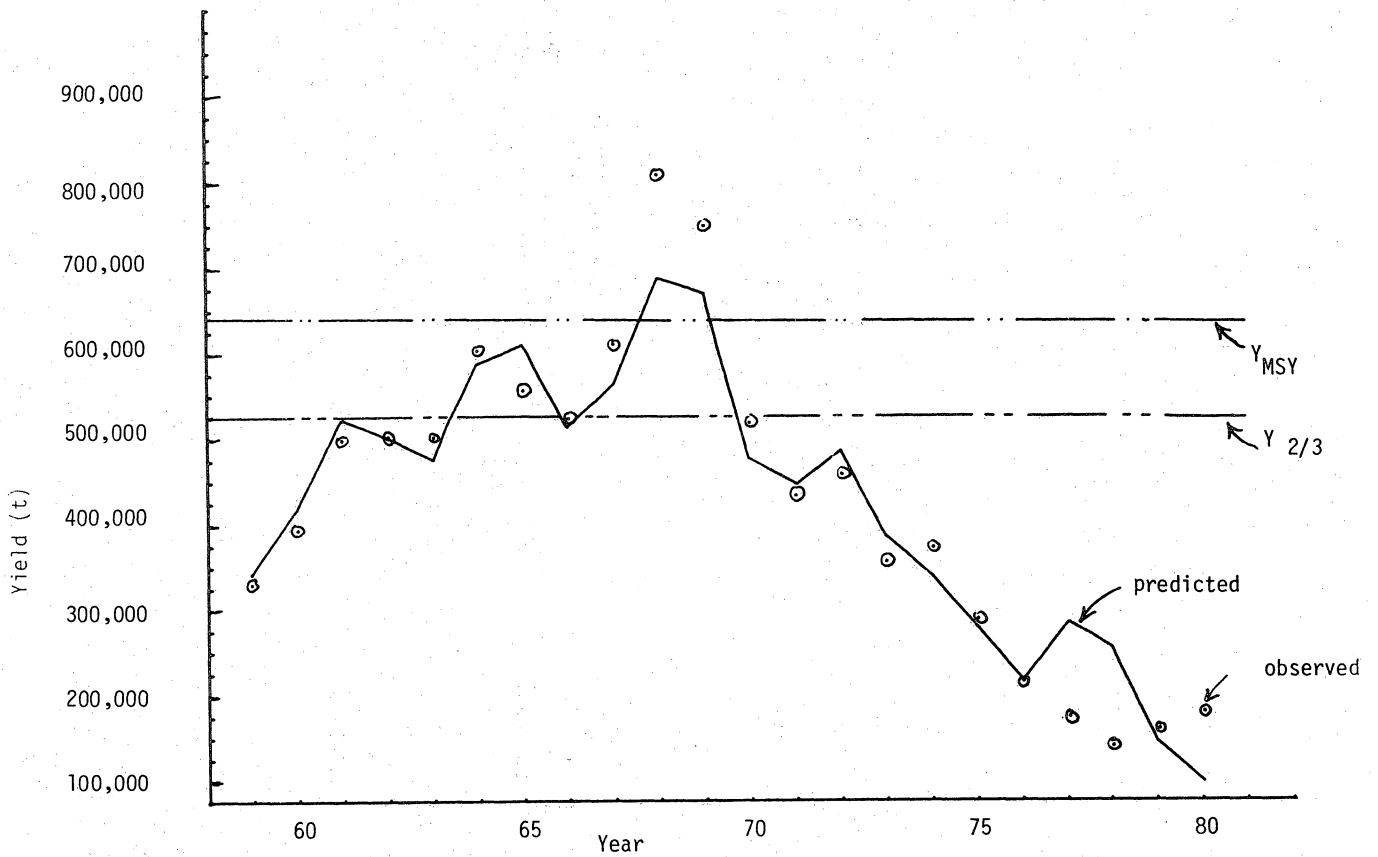


Fig. 2. The predicted and observed values of the dependent variable, yield, for cod in NAFO divisions 2J+3KL. The equilibrium yields at MSY and 2/3 effort MSY are included.

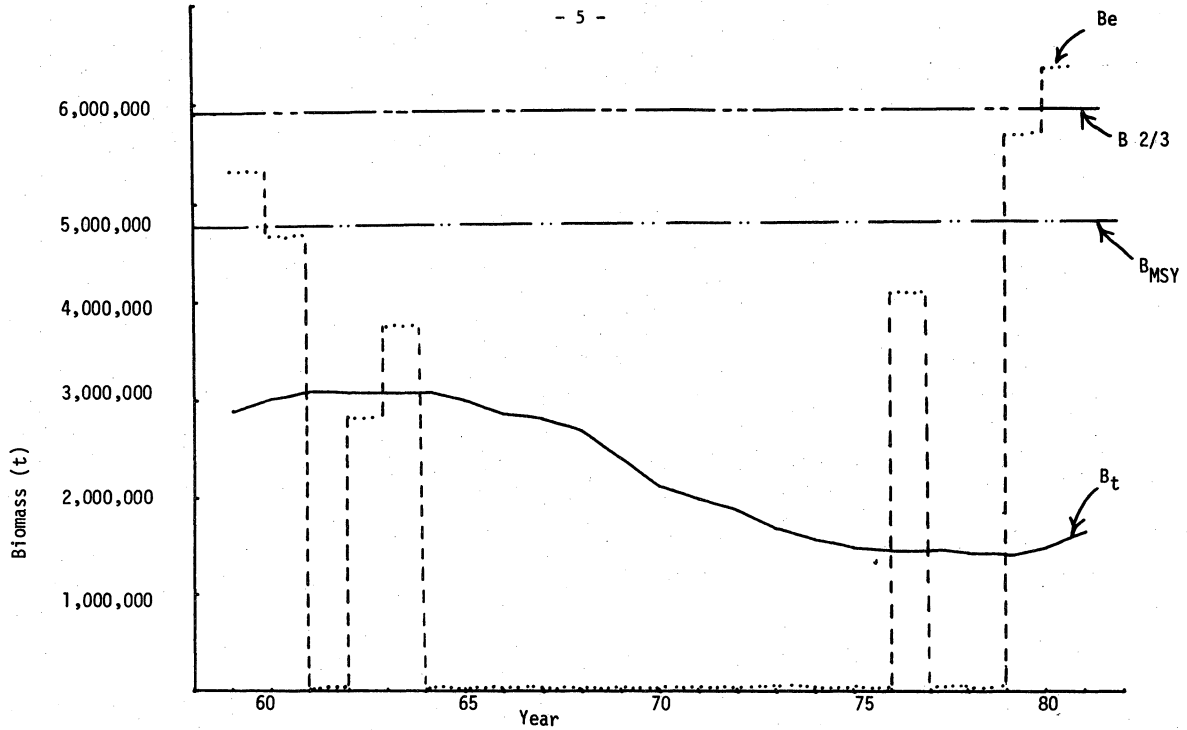


Fig. 3. Predicted trends of biomass, B_t , and the equilibrium biomass, B_e , associated with the effort for that year are shown along with the equilibrium biomass at MSY and at 2/3 effort MSY.

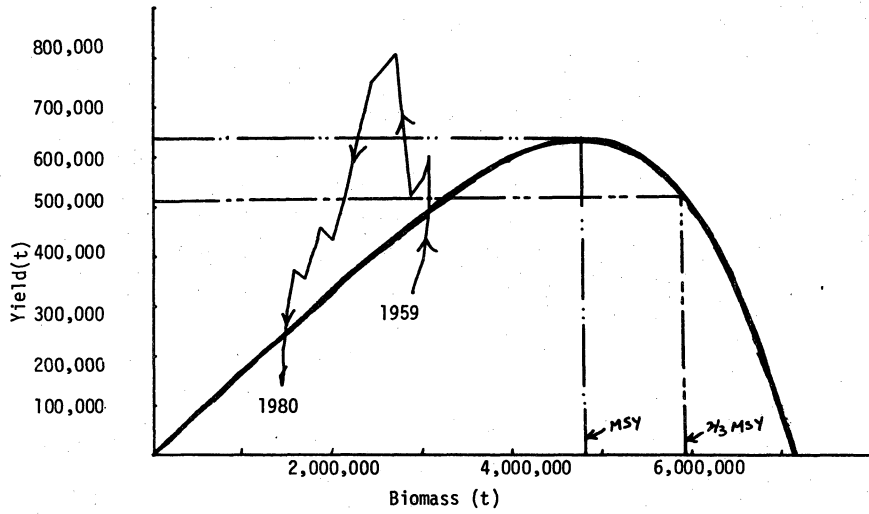


Fig. 4. Equilibrium curve of yield vs biomass and path from 1959-80.

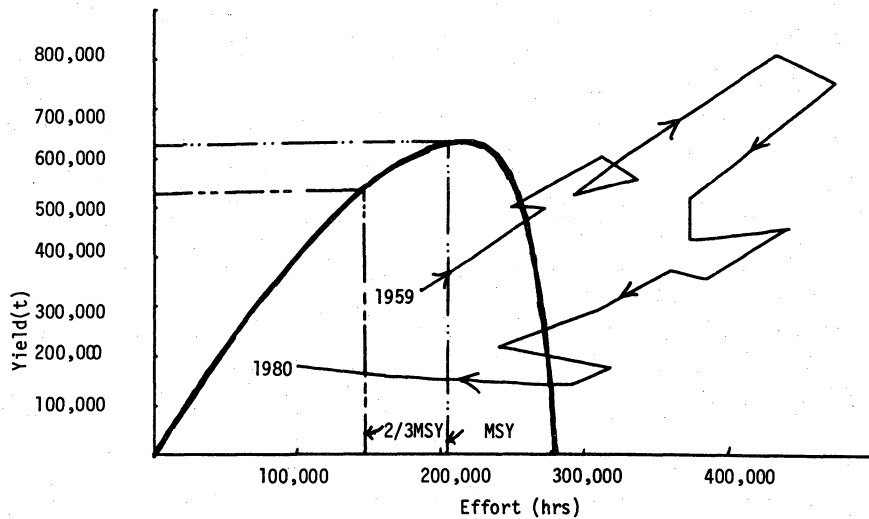


Fig. 5. Equilibrium curve of yield vs. effort and path from 1959-1980.