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Catch/Effort Assessments for the Major Cod Stocks in ICNAF Subareas 2 and 3

by

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Abstract

Estimates of parameters derived during current mesh assessment studies are used in catch/effort assessments of the major cod stocks in ICNAF Subareas 2 and 3. It is concluded that for the stocks in ICNAF Divisions 2J, 3KL, 3NO and 3Ps the level of exploitation is at least close to that generating the maximum sustained yield and may in some cases, notably 3KL and 3Ps, be well beyond this level. Estimates of the actual maximum sustained yields in metric tons are also presented as well as the possible effort changes from the present level of fishing necessary to achieve these maximum yields.

Introduction

Previous catch/effort assessments for Subareas 2 and 3 cod have been reported by Beverton (1965) using 1956-58 data (except for L_∞ and K estimates and hence M/K where 1960-62 data were used) and by May (1967) using 1963-64 data. In both these cases the assessment was based on the constant parameter yield per recruit model as developed by Beverton and Holt (1957) using the FAO yield tables (Beverton and Holt, 1964). In addition, Garrod (1969) assessed the state of the fisheries using a "Schaefer type" model on the catch/effort relationship. His data extended to 1966. In the present study assessments are reported on Subareas 2 and 3 cod using the constant parameter model with the data being taken from the 1964-68 period. Gross estimates of trends in effort and catch per unit of effort are also included.

Materials and methods

Figures used in the calculation of trends in catch and effort were taken from ICNAF Statistical Bulletins for the years 1959-68 and were treated in the following manner: Landings and hours fished for each year were first tabulated by country for those countries reporting hours. Portugal and Spain were found to have the most consistent record of catches in relation to effort over the period and from area to area and were therefore selected as the standard for estimation of total effective effort. Since it has been found by several authors (Hodder, 1965; Wiles, 1967; Pinhorn, 1969a,b) that the ratio of Spanish to Portuguese landing per hour is between 0.8 and 0.9, the hours fished by Spanish otter trawlers and pair trawlers were combined and reduced to 0.8 before being added to Portuguese otter trawl hours. From this effort and the combined landings of the two countries corresponding to it, the landing per standard Portuguese otter trawler hour was calculated for each year. These values were then divided into the total landings of all countries and gears to arrive at an estimate of total effective effort for each year.

Parameters used in constructing yield per recruit curves from FAO Tables are shown in Table 1. Values of L_c shown are averages for the entire fishery in a particular division derived by weighting the L_c's of the various gears in each division by the catch of each gear. Values of L_∞, K and Z are taken from Pinhorn (1969a) and Pinhorn and Wells (1970) and are values used in mesh assessment studies for these same areas. Methods of deriving these estimates are outlined in these papers. Values of M chosen are those believed to cover the range of M likely to occur in these areas, since reliable estimates of this parameter are still not available.

Results

Trends in landings and effort

Total landings from Subarea 2 have shown a marked increase in the 1959-68 period from about 60,000 metric tons in 1959 to 400,000 metric tons in 1968 (Fig. 1). Associated with this has been a corresponding increase in total effort from 50,000 standard Portuguese otter trawler hours in 1959 to 170,000 hours in 1968. Catch per unit effort also increased from 1.3 to 2.4 tons per hour during the same period.

In Divisions 3KL, although total landings have fluctuated somewhat, there has been a general increase from about 270,000 tons in 1959-60 to 420,000 tons in 1968. Total effort fluctuated only slightly around 180,000 hours during 1959-66 but then increased to 240,000 hours in 1968. Landings per hour changed very little over the period although there has been a net increase from about 1.4-1.5 tons in 1959-60 to 1.7-1.8 tons in 1967-68.

Total landings from Division 3M increased from about 7000 tons in 1959 to 54,000 tons in 1965 but decreased to 30-36 thousand tons thereafter. Total effort increased from about 5000 hours in 1959-60 to 40,000 hours in 1965 and decreased to 20,000 hours thereafter. Landings per hour have fluctuated widely around 2 tons per hour.

In Divisions 3NO total landings remained at about 60,000 tons during 1959-64 but then increased to 220,000 tons in 1967. Landings decreased again to 160,000 tons in 1968. Total effort decreased from about 60,000 hours during 1959-61 to 30,000 hours during 1962-63 and then increased steadily to 100,000 hours in 1967. This was followed by a decrease to 80,000 hours in

1968. Landings per hour remained at 1.0-1.2 tons during 1959-62 but then increased to a level of 2 tons during 1963-68.

Having increased from 60,000 tons in 1959 to 80,000 tons in 1961, total landings from 3Ps decreased to a level of 50,000 tons in 1962-65 and then increased to 75,000 tons in 1968. Total effort decreased from 65,000 hours in 1959 to 27,000 hours in 1965 and then increased to 35,000 hours in 1967-68. Landings per hour increased from 1 ton in 1959 to 2 tons in 1968.

Total landings from Division 3PN-4R increased from 50,000 tons in 1959 to 85,000 tons in 1961 and then decreased to 60,000 tons in 1966. This was followed by an increase to 80,000 tons in 1968. Total effort decreased from about 30,000 hours in 1959-62 to 20,000 hours during 1963-66 and then increased to 40,000 hours during 1967-68. Landings per hour rose from 2 tons in 1959-60 to a peak of 3.3 tons in 1964 and then dropped to 1.8 tons in 1967. There was a slight increase to 2.3 tons in 1968.

<u>Catch/effort assessments</u>

Although the lack of reliable estimates of some of the parameters, notably M, precludes a detailed assessment of the stocks of cod in Subareas 2 and 3, some general conclusions about the state of the fisheries can nevertheless be drawn.

For all the major stocks of cod in Subareas 2 and 3, yield per recruit assessments indicate that the level of fishing prevailing during 1964-68 for Divisions 2J, 3KL and 3Ps and 1963-66 for Divisions 3NO was at least near the point of maximum sustained yield per recruit and may in some cases have been beyond it (Fig. 2 and Table 2). This is certainly true of Divisions 3KL where the level of effort was at the point of maximum yield per recruit even at the highest value of M assumed. For all other divisions the most conservative estimate (highest value of M) suggests that the present yield is at least within 90% of the maximum yield per recruit (Table 2). Therefore, assuming constant recruitment at the level prevailing in the period under consideration, an increase in effort is not likely to result in any sustained increase in yield from these fisheries and could result in a decrease on a long-term basis. Also, increased effort will most likely result in a decrease in catch per unit effort, especially if the effort is considered in terms of the cost of operating additional vessels.

From a knowledge of the maximum and current yield per recruit (Fig. 2) and given the actual yield from the fishery in the period considered, an estimate of the level of the maximum sustained yield in metric tons can be derived. These ranges are rather wide in some cases depending on the shape of the particular yield curve but for division 2J the range is 268-278 thousand metric tons, for 3KL 343-440 thousand tons, for 3NO 92-102 thousand tons and for 3Ps 61-76 thousand tons (Table 2). These are very similar but slightly larger than those estimated by the Assessments Subcommittee of ICNAF in 1968. Assuming the correct value of M to lie in the vicinity of 0.2 for cod in the ICNAF area (Beverton, 1965; May, 1967; Horsted, 1969), an estimate of the percentage effort change necessary to achieve maximum sustained yield in the various fisheries can be derived. For Division 2J the present yield (M = 0.22) is very close to that necessary to generate the maximum sustained yield while in the other divisions a reduction of 30-50% in effort would likely result in increased yield on a long-term basis.

Discussion and conclusions

The catch per unit effort and total effort figures shown in Fig. 1 have not been adjusted for secular increases in fishing power of the trawler fleets. Therefore, upward trends in catch per unit effort are probably overestimated and effort underestimated.

The earliest catch/effort assessment on Subareas 2 and 3 cod (Beverton, 1965) concluded that the level of fishing in 1956-58 for both 3KL and 3P cod was probably at or near that producing the maximum sustainable yield while for 3NO cod it was probably beyond the maximum. No assessment of Subarea 2 cod could be made with the available data (1956-58) at the time because of the massive increase in effort in this subarea after 1959. May (1967) concluded that the level of effort in Subarea 2 during 1963-64 was at or beyond that generating the maximum sustained yield, while a study by the Assessments Subcommittee of ICNAF (Redbook 1968, Part I) suggested that the level of fishing on all stocks in Subareas 2 and 3 was at or near that producing the maximum yield. Garrod (1969), using empirical relationships between catch per unit effort and fishing effort, concluded that the level of fishing in the Northwest Atlantic is probably very close to the optimum required to secure a yield close to the potential maximum and certainly not a long way beyond this level.

Similar conclusions concerning the state of the fisheries in Subareas 2 and 3 were reached in the present study for the most recent period for which data were available. The level of fishing was probably close to or beyond that producing the maximum sustained yield. However, the level was nearer the maximum point for Subarea 2 cod than that estimated by May (1967) for 1963-64 and for Divisions 3NO cod than that estimated by Beverton (1965) for 1956-58, but was further beyond the maximum point than that estimated by Beverton (1965) for 3KL and 3Ps cod during 1956-58. These differences resulted from changes in the various parameters used to construct the yield curves and in some cases from changes in F between the two periods (Table 1).

It cannot be emphasized too strongly that the conclusions drawn from catch/effort assessments are only as reliable as the estimates of the various parameters used to construct the yield curves and are only valid if the assumption of a steady, stable fishery, in which recruitment, growth, mortality, fishing effort, etc., remain constant, applies to the fishery in question. Thus, if any of these factors change between periods, then new yield curves would have to be constructed and possibly different conclusions drawn. The point should also be made that the maximum yields given in this paper are maximum sustained yields and should be distinguished from the maximum yield obtainable in any one year. However, assuming a steady state condition prevails, annual yields above the maximum sustained yield could only be maintained with greatly increased effort and then not indefinitely, resulting in decreasing catch per unit effort.

The situation in 3NO is an example of this. In this area recruitment can be quite variable, the survival rate of cod in one year being many times greater or lesser than in an adjacent year. Maximum sustained yield as estimated by the Assessments Subcommittee of ICNAF in 1968 was 75 thousand tons and as estimated in this paper for 1963-66 data was 92-102 thousand tons. However, in 1967 the catch increased drastically to 220,000 tons and in 1968 was still 160,000 tons compared with about 80,000 tons in 1963-66. Associated with this was a sharp increase in effort. This resulted from increased effort on the exceptionally good 1964 year-class of cod when these fish were 3- and 4-year-old, respectively. Unless other year-classes of equal strength followed after 1964, which does not seem to be the case, the level of yield will quickly return to the 1963-66 level. Since this year-class was fished at such an early age, its long-term contribution to the fishery was greatly reduced.

Acknowledgements

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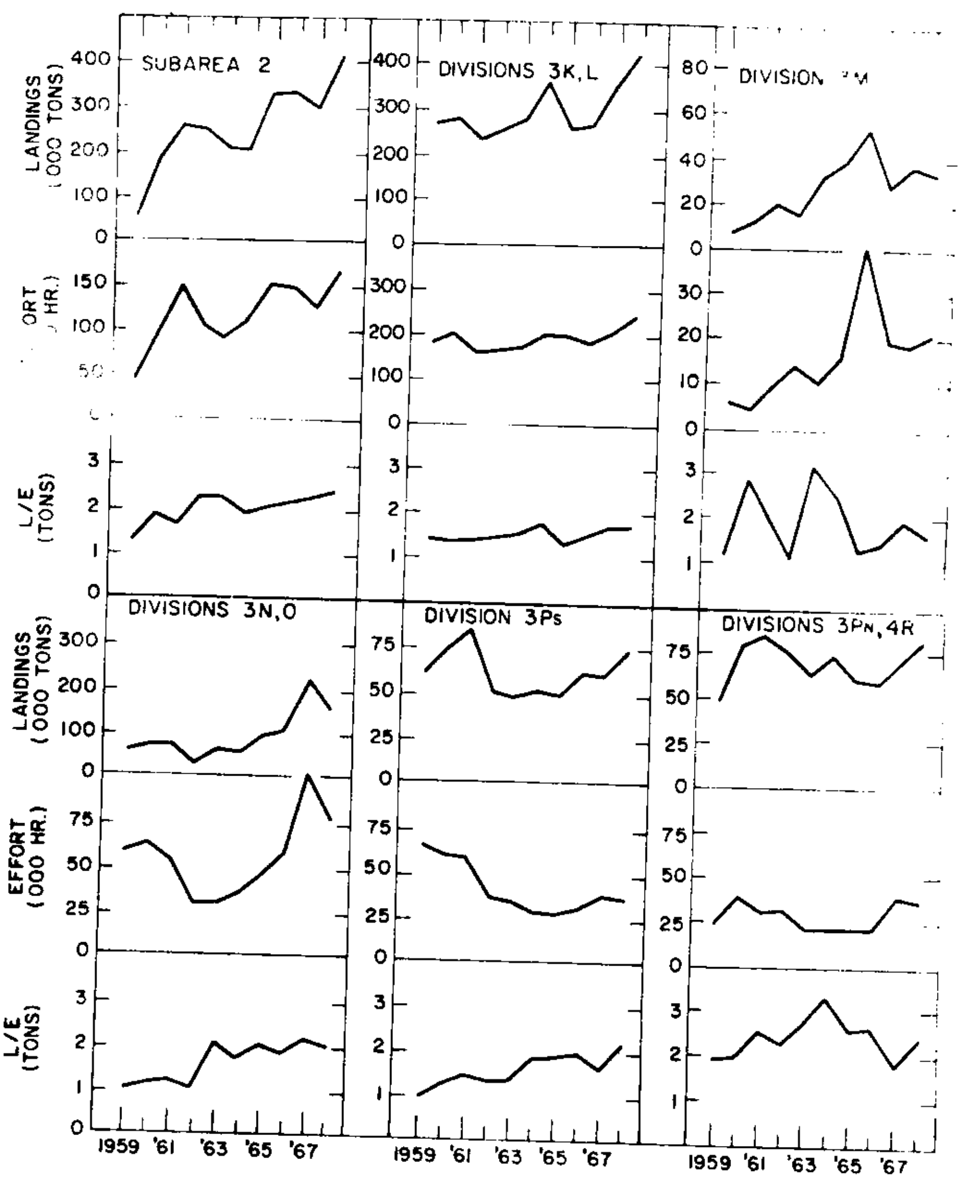

Fig. 1. Landings, effort and landings per effort for the major cod stocks in Subareas 2 and 3 and Division 4R, 1959-68.

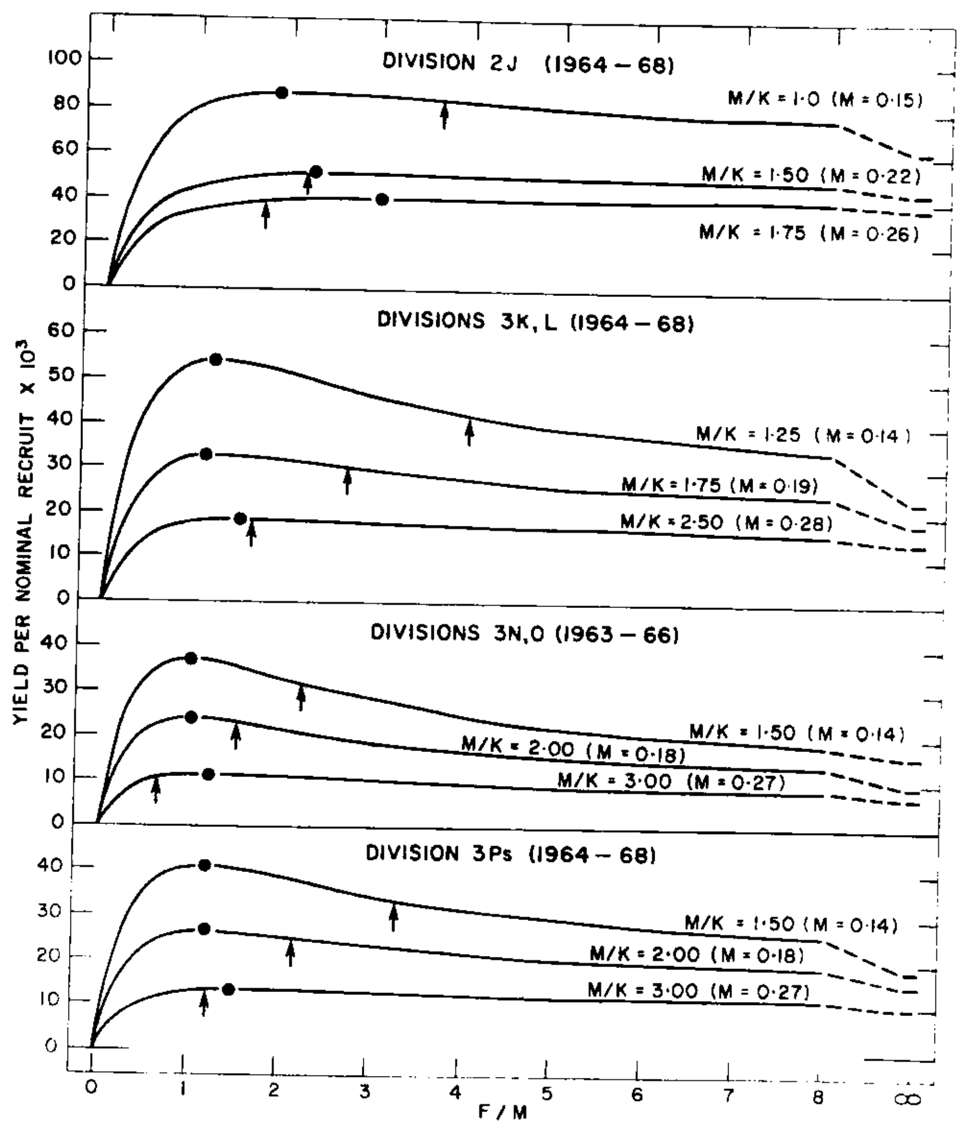

Fig. 2. Yield per recruit curves for the major cod stocks in Subareas 2 and 3. Closed circles indicate the level of fishing mortality generating the maximum sustained yield. Arrows indicate the level of fishing mortality during the period under consideration.

Table 1. Summary of parameters used in constructing yield per recruit curves for Subareas 2 and 3 cod.

ICNAF Division	Source	Period	L_c cm	L_∞ cm	K	Z	E	M	M/K	L_c/L_∞	F/M from E/1-E
2J	Present paper	1964-68	40	81	0.15	0.7	0.64-0.79	0.15-0.25	1.00-1.67	0.49	1.8-3.8
	May (1967)	1963-64	40-45	74	0.2	0.9-1.3	0.78-0.85	0.10-0.30	0.50-1.50	0.54-0.61	3.5-5.5
3KL	Present paper	1964-68	39	114	0.11	0.7	0.64-0.79	0.15-0.25	1.36-2.27	0.34	1.8-3.8
	Beverton (1965)	1956-58	52	95-105	0.2	0.6	0.42-0.75	0.15-0.35	0.75-1.75	0.49-0.55	0.7-3.0
3NO	Present paper	1963-66	38	152	0.09	0.4-0.5	0.38-0.70	0.15-0.25	1.67-2.78	0.25	0.6-2.3
	Beverton (1965)	1956-58	40	130	0.12	0.7	0.50-0.79	0.15-0.35	1.00-2.50	(0.31)	1.0-3.8
3Ps	Present paper	1964-68	42	137	0.09	0.6	0.58-0.75	0.15-0.25	1.67-2.78	0.31	1.4-3.0
	Beverton (1965)	1956-58	46	90-100	0.2	0.6	0.42-0.75	0.15-0.35	0.75-1.75	0.46-0.51	0.7-3.0

Table 2. Calculation of maximum yields and effort changes for Subareas 2 and 3 cod stocks, 1964-68.

ICNAF Division	Z	M	F	Current Y'	Maximum Y'	1964-68 yield ('000 tons)	Maximum yield ('000 tons)	% current is of maximum	Maximum yield from 1968 Redbook	Curr F/M	Max F/M	% effort change
2J	0.70	0.15	0.55	0.084	0.087		278	+96.6				
		0.22	0.48	0.051	0.051	268	268	100.0		2.18	2.33	+6.9
		0.26	0.44	0.040	0.041		275	-97.6	600			
3KL	0.70	0.14	0.56	0.042	0.054		440	+77.7				
		0.19	0.51	0.031	0.033	343	365	+93.9		2.68	1.22	-54.5
		0.28	0.42	0.019	0.019		343	100.0				
3NO*	0.45	0.14	0.31	0.032	0.037		102	+86.5				
		0.18	0.27	0.023	0.024	89	92	+95.8	75	1.50	1.00	-33.3
		0.27	0.18	0.011	0.012		97	-91.7				
3Ps	0.60	0.14	0.46	0.033	0.041		76	+80.5				
		0.18	0.42	0.025	0.027	61	66	+92.6	60†	2.33	1.22	-47.6
		0.27	0.33	0.013	0.013		61	100.0				

*1963-66

†This is obtained by considering half of the potential yield of 120 for 3P-3PN-4R as given in Redbook 1968, Part I to be applicable to 3Ps.