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The Estimation of Total Allowable Catch of Red Hake from the Georges Bank for 1975

by

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ABSTRACT

In the present paper the estimate of total allowable catch of red hake for 1975 is given, based on combined utilization of various methods (virtual population analysis, groundfish trawling surveys, the estimation of catch per recruitment ratio).

INTRODUCTION

Beginning from 1974, red hake from the Georges Bank is among the species, the fishery of which is regulated by an introduction of a quota as a compulsory measure. The quota is introduced on the basis of a scientific estimate of total allowable catch (TAC). In present report prepared for consideration at the next Annual ICNAF Meeting in 1974, the assessment of total red hake catch which can be taken from the Georges Bank area in 1975 is given.

METHODS

The prognosis of possible red hake catch from the Georges Bank for 1975 was made according to a scheme described in the paper "A Method of Prognosis and an Approximated Estimate of Total Allowable Catch of Red Hake from the Southern New England"

by Rikhter, which is presented at the same ICNAF Meeting. In estimation the age-composition data of commercial catches for the years 1965-1972 including were used, as well as the abundance indices of the young of the year fish obtained during the groundfish surveys (Anderson, 1974).

Some contradictions marked by Anderson (1974) in the "length-age" keys, really give rise to doubt in reliability of certain age determinations for fish older than 3 years. However, the comparison of mean annual red hake length of different age groups determined after recalculation for massive measurements (table 1), though not eliminating all the discrepancies gives better results, which allow to utilize the age composition data of commercial catches for approximate estimation of the stock.

Table 1

Mean annual length (cm) of red hake
of different age groups by year-classes

Age, years	Age-classes								
	1963	1964	1965	1966	1967	1968	1969	1970	1971
2	30.2	29.8	27.2	29.1	24.1	26.4	28.5	26.4	27.7
3	31.9	31.2	30.5	29.9	32.2	32.8	30.4	30.5	-
4	33.8	32.5	35.3	38.2	36.5	33.2	33.3	-	-
5	34.2	35.5	41.6	40.6	35.8	35.4	-	-	-

The discrepancies in mean fish length of the same age may be explained to a considerable extent by various growth rate of different year-class individuals. The cases of obvious discrepancies result rather from the lack of systematic character in sampling and from the errors in age determination. As regards the fish older than 5 years, their number in samples is too insignificant, as a rule, to give the right idea of length composition of these age-group fish.

The catch per recruitment (Yw/R) ratio was estimated according to Kutty (1968). The averaged weight of every age-group fish for 8 years was used.

The utilization of a given scheme of prognosis requires the knowledge on what amount of fish of different age-groups is removed annually from a total catch, which can be taken from a corresponding year-class during the whole period of its exploitation. Here, as well, we had to resort to estimation of mean catch per cent for every age group of total amount of fish caught during the whole exploitational period.

The commercial stock size for the period of 1965-1972 including, and the abundance of two year old fish (recruitment) were estimated by a virtual population analysis (Schumacher, 1970).

INVESTIGATION RESULTS

For estimation of stock size by a virtual population analysis, three values of natural mortality rate (M=0.8; 0.6 and 0.4) at a constant fishing mortality (F=0.7) were taken.

This choice was stipulated by an assumption, that the value of M is reduced as a result of intensive fishing. In the first two variants (M=0.8 and 0.6) the values of M for all age groups are constant. In the third variant M=0.6 is taken for two year old fish, since the fishing intensity of this age group on the Georges Bank is insignificant (lower than in the area southward of 69°W).

As a result of calculations, we had three variants of abundance estimates at our disposal, from which the best ones were to be chosen. A comparison with the estimates obtained by means of a catchability coefficient (a direct calculation method) showed, that even the estimates of the third variant (M=0.4) considerably exceeded the biomass values calculated by another method (table 2).

Table 2

Stock size estimates calculated for the Georges Bank population by a virtual population analysis and a direct calculation method

(thous. t.)

Years	1965	1966	1967	1968	1969	1970	1971	1972
Virtual population analysis (M=0.4)	172	96	49	41	42	67	89	57
Direct calculation method	50	40	27	11	25	26	11	35
Total catch	55	40	27	5	5	2	9	32

It is evident from the table that a difference between the estimates is considerable, however, the lower line in the table throws light on the situation. The comparison with actual catches for the above years is indicative of unapplicability of a direct calculation method relative to the Georges Bank population, and speaks in favour of reliability of estimates obtained by a Schumacher's method. It is most likely that a catchability coefficient in reality is considerably lower as compared with the value given in the paper by Edwards (1968), owing to peculiarities in distribution and behaviour of red hake on the Georges Bank. Speaking of the reality of the third variant estimates, we can cite as an indirect confirmation a comparison of values calculated by two methods for a population inhibiting the area westward of 69°W, where the catchability factor of Edwards is acceptable (Rikhter, a paper on assessment of red hake catch from the southern New England).

Summarizing the aforesaid we can suggest that the third variant gives the most reliable stock size estimate for the Georges Bank population as well, which were used in further calculations (table 3).

The catch per recruitment (Yw/R) ratio was calculated with regard for the following assumptions: in the third year of the life cycle M reduced by 20% of the original value of 0.8 as a result of fishing, and in the age of 3-6 years - by 50%; F for two year old fish is 0.2 , and for the following age groups - 0.7. The fact of an increase in M value with age under the influence of natural factors was also taken into consideration (Rikhter, 1972).

The results of calculation are shown in table 4.

Table 3

The assessment of the Georges Bank red hake abundance by means of a virtual population analysis (in millions) $M_2 = 0.6$; $M_{3-6} = 0.4$

Age	Year-classes											
	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
2	-	-	-	-	344.9*	190.0*	101.8*	144.5*	175.0*	252.0*	202.5*	109.4
3	-	-	-	199.6	137.8	84.6	37.6	77.0	89.5	116.5	90.0	
4	-	-	113.0	79.4	47.8	14.7	22.9	52.5	57.1	66.0		
5	-	60.3	22.4	20.3	34.2	6.6	3.2	33.2	32.3			
6	13.4	20.1	6.1	4.5	19.5	3.0	2.0	18.7	-	-	-	-

* Two year old fish abundance was estimated by a formula:

$$N_i = \frac{N_{i+1}}{e^{-z}}$$

Table 4

The calculation of catch per recruitment (Yw/R) ratio according to Kutty

Age, years	2	3	4	5	6	Yw/R
N_t	1.0	0.58	0.22	0.08	0.02	
$\bar{W}_t$	137	198	248	294	343	
$F_t N_t \bar{W}_t$	24.6	57.5	27.3	11.7	3.4	110.5

N_t - the abundance of age groups in relative units;

W_t - the mean observed value in grams;

$F_t N_t W_t$ - the catch of every age group in grams.

Now, having the value of the Yw/R ratio and the recruitment abundance indices it is easy to estimate total catch, which can be taken from every year-class during the whole exploitational period. In 1975 the bulk of the catch will be represented by fish of the 1969-1973 year-classes (2-6 year olds). The rounded off abundance of the 1969-1970 year-classes constitutes 202 and 110 millions, accordingly (table 3). Based on the data of the young of the year fish abundance indices (Anderson, 1974), the 1971 and 1973 year-classes were equated in abundance with the 1969 year-class. It was decided to consider the abundance of the 1972 and 1970 year-classes approximately equal. Now, as soon as the data on the mean per cent of every age group removal of the total amount of the fish caught during the whole exploitational period is available, it is possible to estimate the red hake TAC from the Georges Bank area for 1975 (table 5).

Table 5

The approximated estimate of the red hake TAC from the Georges Bank for 1975

Age, years / year-classes	1 / 1973	2 / 1972	3 / 1971	4 / 1970	5 / 1969	Optimum catch
Total catch from year-classes during their exploitation (in thous.)	22.3	12.2	22.3	12.2	22.3	
The share of every age group (%%)	13.3	30.0	35.6	13.2	7.9	
The catch from every age group (in thous.)	3.0	3.6	7.9	1.6	1.8	17.9

In our calculations we allowed for the 2-6 year old fish. It is high time to mention that about 7% of catch by weight taken from the Georges Bank area was represented by red hake of 7-9 year old. Therefore, the optimum catch value given in table 5 (approximately 18 thous. tons) is somewhat underestimated. Taking into account the role of red hake older than 6 years in fishery, we can express the TAC estimate for 1975 as about 20 thous. tons.

SUMMARY

The precision of the value of feasible red hake catch in 1975, given in the present paper is determined by a reliability level of initial parameters and assumptions accepted. However, the experience of previous investigations and the comparison of the results obtained with the estimates for recent years, allows to expect that the figure of recommended red hake catch from the Georges Bank for 1975 (20 thous. tons) is sufficiently well grounded.

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