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Recruitment and stock abundance estimates to 1973 for 4T-V-W haddock

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INTRODUCTION

The relationship between prerecruit haddock year-class abundance in summer research vessel cruises in ICNAF Div. 4W in 1958-60 and the subsequent abundance of these year-classes in the commercial fishery, was described by Halliday (ICNAF Res. Doc. 70/75). This relationship:

$$\log_e Y = 1.4457 + 0.5785 \log_e X \quad \text{--- equation 1}$$

where Y is abundance at age 4 estimated from the commercial fishery and X is average abundance at ages 1-3 estimated from survey data, was used to predict abundance of 1966-68 year-classes at recruitment to the fishery at age 4 in 1970-72. Survey abundance estimates for these 1966-68 year-classes were obtained from a research vessel cruise in Div. 4W in July 1969.

On the basis of these predictions, and data on effort, and quantity and age composition of landings for the commercial fishery, the status of the stock in terms of available population, removals, and recruits was described for 1967-69 and predicted for 1970-72. It was concluded that the available population, which averaged about 30 million fish in 1967-69 and yielded about 12,000 metric tons annually, would be reduced to about 20 million fish and yield reduced to 9,000 metric tons in 1972, if fishing mortality (F) remained at 0.50 - the value giving maximum yield per recruit. Historical data on landings indicate that this stock is capable of giving a sustained yield of about 25,000 metric tons.

Another research vessel survey of prerecruit haddock abundance in Div. 4W was undertaken in July 1970 giving improved estimates of the strength of the 1967 and 1968 year-classes and a first estimate of the strength of the 1969 year-class. Final estimates of effort, and quantity and age composition of landings for the commercial fishery in 1969 are now also available. Thus, it is possible to provide revised predictions of stock status updated to include 1973.

RECRUITMENT PREDICTIONS

The July 1970 prerecruit survey was undertaken in an identical manner to that of July 1969 described by Halliday (ICNAF Res. Doc. 70/75). A total of 37 randomly selected stations

were occupied in 9 strata covering most of the offshore region of Div. 4W. Estimates of the total numbers of haddock of each age group present were calculated by raising catch per unit area by the area of the stratum and summing over strata. This gave estimates of numbers present of 1967-69 year-classes of:

Year-class	Age	Numbers
1967	3	3,019,000
1968	2	1,475,000
1969	1	5,350,000

Abundances of the 1967 and 1968 year-classes in July 1969 at ages 2 and 1 respectively were 3,717,000 and 1,878,000. It was predicted that abundance in July 1970 should be 2,899,000 and 1,465,000 for 1967 and 1968 year-classes respectively (Halliday, Res. Doc. 70/75) using an estimate of  $Z (\cong M) = 0.25$  derived from observations on mortality of 1956-58 year-classes at comparable ages. The observed values in July 1970 are remarkably close to those predicted, differing by 120,000 fish for the 1967 year-class, and by only 10,000 for that of 1968.

To obtain estimates of average abundance at ages 1-3 of 1967-69 year-classes for substitution in equation (1), abundance estimates of the 1967 year-class at age 1, the 1968 year-class at age 3, and the 1969 year-class at ages 2 and 3, are calculated from observed values using a Z value of 0.25 in the equation

$$N_{i+1} = N_i e^{-Z} \quad \text{--- equation 2}$$

where  $i$  denotes age.

Predictions of year-class strength at entry to the fishery at age 4 are 9.0, 5.5, and 10.0, million fish for 1967-69 year-classes respectively (Table 1).

### STOCK ABUNDANCE PREDICTIONS

Final statistics on landings and effort for 1969 indicate that landings were slightly lower and abundance slightly higher than indicated by the preliminary values used by Halliday (Res. Doc. 70/75), and thus, give a marginally more favourable view of current stock status. Average available population in 1967-69 was 31 million fish and average yield was 12,000 metric tons for fishing mortality rates of 0.43-0.57 (Table 2). If fishing mortality stays about 0.50, the value giving maximum yield per recruit, the population is predicted to decline to 22 million fish in 1972-73, and yield in 1973 is unlikely to be very different from 8,500 metric tons.

## DISCUSSION

The estimate of the available population in 1969 of 30.3 million haddock calculated from the catch in that year does not correspond exactly to that of 27.1 million calculated as survivors of the stock in 1968. Comparable values for 1968 and 1967 are closer at 30.5 million and 29.8 million respectively. These discrepancies reflect sampling errors and errors in population parameters used in the calculations, and thus give some impression of the errors likely to prevail in the predictions for the fishery in 1970-73. Undoubtedly, the greatest likelihood of error lies in recruitment predictions. It has been established that abundance of haddock year-classes at ages 1-3 in survey cruises is significantly correlated to abundance in the commercial fishery at age 4. However, to use this relationship as described by equation 1 for predictive purposes is justified only by the urgent need for such predictions in order to provide the best possible basis for regulation. Rough calculations indicate that the probability of the number of recruits at age 4 being over 100% greater, or 50% less, than the predicted values in Table 1 are considerably higher than 5%. Despite this, there can be little doubt that the 1967-69 year-classes can be categorized as "poor" and will not bring about any significant recovery of the fishery. Thus, the conclusion that no significant improvement in this fishery can be expected prior to 1974 at the earliest, seems justified.

TABLE 1. Abundance of 1966-69 year-classes at ages 1-3 and mean abundance, estimated from survey cruises, and abundance at age 4 estimated from equation (1). (Asterisks denote values calculated using  $Z = 0.25$ .)

Age	Y E A R C L A S S		
	1966	1967	1968
1	10,472,000*	4,765,000*	1,878,000
2	8,168,000*	3,717,000	1,475,000
3	6,371,000	3,019,000	1,151,000*
Mean of Ages 1-3	8,300,000	3,800,000	1,500,000
Estimated Abundance at Age 4	14,500,000	9,000,000	5,500,000
			10,000,000

TABLE 2. 4T-V-W haddock: available population, removals, recruits, fishing mortality (F), and yield 1967-73.

	CALENDAR YEAR						
	1967	1968	1969	1970	1971	1972	1973
Available popn. $\times 10^{-6}$	33.0	30.5	30.3	32.7	28.2	21.6	22.0
Removals $\times 10^{-6}$							
Total	13.2	14.0	12.1	13.6	12.1	9.6	9.1
Fishing	8.0	9.4	7.4	8.5	7.8	6.3	5.7
Natural	5.2	4.6	4.7	5.1	4.3	3.3	3.4
Recruits at age 4 $\times 10^{-6}$	10.0	10.6	14.5	9.0	5.5	10.0	?
Fishing mortality F	0.47	0.57	0.43	0.50	0.50	0.50	0.50
Landings (metric tons)	11,000	13,500	11,000	12,500	11,500	10,000	8,500
	Observed values			Estimated values			

