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ICNAF Div. 4X haddock - implications of 1975 data

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Introduction

Preliminary 1975 nominal catches are 18,273 mt from a TAC of 15,000 mt, up from 1974 catches of 13,234 mt (Table 1). The TAC set for 1976 is also 15,000 mt. It was the intent of the 1975 regulations (and of those for 1976) that the TAC should cover unavoidable bycatches only and that no directed fishery for haddock be allowed.

In 1974, the smaller Canadian trawlers had difficulty fishing without exceeding bycatch allowances and some discarding at sea took place. The quantities involved and their size composition are unknown. The larger trawlers largely avoided fishing Div. 4X as it was extremely difficult to stay within bycatch limits. The smaller vessels, however, do not have the mobility to fish elsewhere. Bycatch regulations were modified in 1975 in an attempt to avoid these problems. These modifications largely eliminated discards from small trawlers, but the larger trawlers still had difficulties with bycatches, particularly in the spring, and again quantities of haddock were discarded. These cannot be quantified, and their size composition is not known. While these bycatches cannot be taken into account directly in stock assessment, their effects on the calculations should be taken into consideration to as large a degree as possible.

Composition of landings in 1975

A total of 14.45×10^6 fish were removed in 1975, up from about 9.0×10^6 fish per year in 1972 to 1974 (Table 2). The 1971 year-class contributed most strongly to the 1975 catch, followed closely by the 1972 year-class. The 1973 year-class also contributed heavily in terms of numbers, but the 1969 year-class contributed more in tonnage.

Research vessel survey results in 1975

Groundfish surveys, based on a stratified-random sampling design, have been conducted in Div. 4X since 1970. Population estimates for 1975 of 38×10^6 fish and 36,840 mt are comparable to levels in earlier surveys with the exception of 1974 (Table 3). It is apparent from a comparison of abundance estimates of the same year-classes in 1973 and 1974, and with USA survey results, that Div. 4X haddock were more available to the Canadian survey gear in 1974.

The 1971 year-class was the most abundant in the 1975 survey, and the initial showing of the 1974 year-class was moderately strong. Among older age-groups, the 1969 year-class continued to show a moderate abundance.

Mortality rates of age-groups fully recruited to the fishery (age 5 and older) estimated from surveys fluctuate widely and little reliance can be placed on year-to-year estimates. Averaging over the series of five observations suggests an average total mortality of $Z = 0.55$ during the period, and a similar, perhaps lower value, applying to the more recent 1973-75 period (Table 3). Assuming $M = 0.20$ gives $F = 0.35$.

Cohort analysis

Removals at age from Table 2 for 1965-75 were subjected to cohort analysis with starting F values for ages 4 and older in 1975 of 0.35. Age 4, the 1971 year-class, was thus assumed to be fully recruited to the fishery. The population number at age and F at age estimates obtained are given in Table 4.

Year-class size estimates at age 2 confirm that the 1963 year-class was exceptionally strong, and that subsequent year-classes were very poor at less than 15×10^6 fish until the 1969 year-class appeared. The calculated size of the 1969 year-class of about 22×10^6 fish is close to the strength estimated from juvenile surveys of 20×10^6 fish used in earlier assessments. The 1970 year-class is confirmed as the poorest on record. The 1971 year-class estimate of 38×10^6 fish is close to that of 40×10^6 fish estimated from juvenile surveys.

Fishing mortality on the stronger 1969 and 1971 year-classes has been moderate and the stock is not presently being overfished from a yield-per-recruit viewpoint. F_{max} is in the order of 0.40-0.50 by analogy with adjacent haddock stocks. However, stock abundance is considerably below that of the early 1960's. Spawning stock size (age 4+) in 1962-63 was about 80,000 mt. There was a substantial increase in 1967 to 135,000 mt with maturation of the 1963 year-class, but this was followed by a decline to 37,000 mt by 1972. A slight rise when the 1969 year-class matured was offset by the poor 1970 year-class, and by 1974, spawning stock biomass was at its lowest level at 31,000 mt. The 1975 level increased due to maturation of the 1971 year-class to 45,000 mt. This is still well below the 70,000-80,000 mt level obtaining prior to the recruitment failure of the mid-1960's, and the management regime should continue to be based on an objective of stock rebuilding.

Recruitment prospects

The following data series giving abundance of juvenile haddock from Canadian and USA (personal communication: Northeast Fisheries Centre, USA) research vessel surveys and from cohort analysis show a good correspondence:

| | Year class | | | | | | | |
|--|------------|------|------|------|------|------|------|------|
| | 1964 | 1965 | 1966 | 1967 | 1968 | 1969 | 1970 | 1971 |
| Cohort estimate at age 2 | 14.2 | 8.3 | 14.1 | 7.3 | 12.3 | 21.9 | 4.0 | 38.3 |
| USA surveys age $\overline{0+1}$ no./tow | 1.9 | 2.1 | 2.0 | 0.5 | 3.1 | 7.3 | 0.0 | 16.6 |
| Can. surveys age $\overline{1+2}$ popn. ¹ | | | | | | 11.6 | 0.2 | 19.3 |

¹Canadian surveys adjusted for increased availability in 1974.

The observed survey values for 1972-74 year-classes and corresponding predictions of cohort size at age 2 are:

| | <u>USA</u> | | <u>Canada</u> | |
|------|---------------|-----------------------|---------------------|-------------------------|
| | <u>Survey</u> | <u>YC size</u> | <u>Survey</u> | <u>YC size</u> |
| 1972 | 8.5 | 23 x 10 ⁶ | 11.6 | 22 x 10 ⁶ |
| 1973 | 1.8 | 9.5 x 10 ⁶ | 6.6 | 13.5 x 10 ⁶ |
| 1974 | 5.5 | 17 x 10 ⁶ | (13.6) ¹ | (26 x 10 ⁶) |

¹Observed at age 1 only.

The survey data are in excellent agreement on the strength of the 1972 year-class, and this can be assumed to contain 22 x 10⁶ fish at age 2. Moderately good agreement is also obtained for the 1973 year-class. Canadian surveys are more optimistic on the size of the 1974 year-class, but this is based on only one year of observation, while the USA estimate is based on two years of observations. Given the longer data series of USA surveys and their consistency with observed year-class strengths, more reliance should be placed on them than on the much shorter Canadian data series. Thus, the 1973 and 1974 year-classes are likely in the order of 10⁷ fish and 17 x 10⁶ fish respectively. It is likely, then, that spawning stock size will decline again in 1977 and 1978.

Catch projections

Applying the recent average fishing mortality determined from surveys for 1975 of $F = 0.35$, and using the recruitment estimates derived above, the fishery was projected through 1978 to determine the effects of continuing present management policy of no directed fishing. As it has been indicated in the Commission that by-catches cannot be reduced below 15,000 tons, this catch was used in each year from 1976 to 1978. Catches at this level will result in $F = 0.30$ in 1976 and 1977 with a slight increase to 0.33 in 1978. Spawning stock biomass (age 4+ at beginning of year) will increase in 1976 but decrease moderately thereafter to 39,000 tons in 1978. This is approximately half the desired level, and 6,000 tons above the lowest recorded level observed for 1974.

Discussion

It is apparent from Table 5 that despite maintaining the present regulations of no directed fishery, and with by-catches estimated at 15,000 tons, predicted recruitment is not at a sufficiently high level to allow the spawning stock to continue increasing. The high partial recruitments required to account for catches of the 1972 and 1973 year-classes in 1975 could be an indication of underestimation of the size of these year-classes. Should this be so, the spawning stock would not necessarily decrease in 1977. However, it is apparent that such an error is unlikely to be sufficiently big to bring the spawning stock to the desired level of at least 70,000 tons, and hence does not provide a rationale for changing the present management regime.

Table 1. Div. 4X haddock - nominal catches (mt) 1965-75.

| <u>Year</u> | <u>Canada</u> | <u>Spain</u> | <u>USSR</u> | <u>USA</u> | <u>Others</u> | <u>Total</u> |
|-------------------|---------------|--------------|-------------|------------|---------------|--------------|
| 1965 | 22,740 | - | 2,582 | 3,685 | - | 29,007 |
| 1966 | 29,543 | 143 | 10,065 | 2,473 | - | 42,224 |
| 1967 | 32,012 | 78 | 199 | 5,014 | - | 37,303 |
| 1968 | 28,837 | 116 | 335 | 3,156 | 36 | 32,480 |
| 1969 | 28,074 | 473 | - | 1,830 | 19 | 30,396 |
| 1970 | 16,012 | 370 | 2 | 1,743 | 12 | 18,139 |
| 1971 | 16,404 | 347 | 97 | 751 | 1 | 17,600 |
| 1972 | 12,570 | 470 | 10 | 448 | 1 | 13,499 |
| 1973 | 12,680 | 134 | 14 | 269 | 6 | 13,103 |
| 1974 | 12,434 | 97 | 35 | 668 | - | 13,234 |
| 1975 [✓] | 16,092 | - | 39 | 2,142 | - | 18,273 |

[✓] Preliminary and incomplete statistics.

Table 2. Div. 4X haddock - numbers removed at age ($\times 10^{-3}$), 1966-75.

| <u>Age</u> | <u>1966</u> | <u>1967</u> | <u>1968</u> | <u>1969</u> | <u>1970</u> | <u>1971</u> | <u>1972</u> | <u>1973</u> | <u>1974</u> | <u>1975[✓]</u> |
|------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------------------|
| 1 | - | - | - | - | - | - | 41 | 150 | 1 | 37 |
| 2 | 219 | 22 | 665 | 10 | 1,055 | 788 | 22 | 3,077 | 694 | 2,175 |
| 3 | 18,341 | 515 | 297 | 2,016 | 724 | 1,617 | 3,434 | 113 | 4,653 | 4,568 |
| 4 | 9,796 | 20,380 | 1,164 | 1,986 | 1,502 | 788 | 1,841 | 2,247 | 309 | 5,164 |
| 5 | 3,167 | 9,148 | 17,448 | 1,621 | 379 | 1,422 | 509 | 1,067 | 1,779 | 485 |
| 6 | 2,149 | 1,039 | 4,684 | 11,243 | 524 | 404 | 645 | 527 | 509 | 1,103 |
| 7 | 3,747 | 735 | 713 | 3,220 | 4,536 | 69 | 90 | 600 | 189 | 247 |
| 8 | 840 | 1,052 | 518 | 455 | 1,863 | 3,316 | 57 | 322 | 269 | 172 |
| 9 | 409 | 187 | 672 | 249 | 133 | 1,020 | 1,166 | 259 | 186 | 62 |
| 10 | 424 | 102 | 190 | 194 | 96 | 163 | 512 | 614 | 269 | 32 |
| 11 | 88 | 90 | 131 | 172 | 175 | 181 | 26 | 55 | 552 | 165 |
| 12 | 62 | 23 | 65 | 94 | 27 | 146 | 193 | 13 | 24 | 229 |
| 13+ | 84 | 81 | 89 | 69 | 37 | 105 | 92 | 6 | 4 | 11 |
| Totals | 39,327 | 33,373 | 26,635 | 21,311 | 11,050 | 10,017 | 8,628 | 9,050 | 9,438 | 14,450 |

[✓] Preliminary.

Table 3. Div. 4X haddock - estimated population numbers at age ($\times 10^{-3}$), and Z on fully recruited age groups from Canadian research vessel surveys. (Strata 70-95 inclusive).

| <u>Age</u> | <u>1970</u> | <u>1971</u> | <u>1972</u> | <u>1973</u> | <u>1974</u> | <u>1975</u> |
|--------------|-------------|-------------|-------------|-------------|-------------|-------------|
| 1 | 7,989 | 161 | 7,248 | 8,162 | 15,781 | 9,049 |
| 2 | 6,429 | 15,191 | 319 | 31,432 | 32,451 | 5,843 |
| 3 | 1,883 | 6,483 | 4,598 | 796 | 46,721 | 7,355 |
| 4 | 3,554 | 2,925 | 1,988 | 4,099 | 1,443 | 10,357 |
| 5 | 1,445 | 4,230 | 1,276 | 1,937 | 6,011 | 697 |
| 6 | 3,253 | 1,990 | 1,401 | 752 | 1,355 | 2,490 |
| 7 | 8,477 | 3,026 | 905 | 1,046 | 747 | 859 |
| 8 | 1,191 | 8,373 | 1,446 | 794 | 861 | 481 |
| 9 | 483 | 1,046 | 2,206 | 554 | 480 | 229 |
| 10 | 438 | 128 | 77 | 801 | 357 | 74 |
| 11 | 112 | 56 | 9 | 39 | 502 | 472 |
| 12 | 28 | 156 | 7 | - | - | 274 |
| 13+ | - | - | 19 | 13 | - | - |
| NK | - | - | 108 | - | - | - |
| Total Nos. | 35,282 | 43,765 | 21,609 | 50,425 | 106,709 | 38,179 |
| Biomass (mt) | 38,150 | 49,680 | 23,900 | 29,260 | 67,440 | 36,840 |

$$\bar{Z}_{5+/6+} \quad 0.04 \quad 1.12 \quad 0.62 \quad 0.32 \quad 0.75$$

$$\bar{Z}_{6+/7+} \quad 0.09 \quad 1.13 \quad 0.64 \quad 0.31 \quad 0.59$$

$$\bar{Z}_{5+/6+} (1970-75) = 0.57 \quad \bar{Z}_{5+/6+} (1973-75) = 0.54$$

$$\bar{Z}_{6+/7+} (1970-75) = 0.55 \quad \bar{Z}_{6+/7+} (1973-75) = 0.45$$

Table 4 . Div. 4X haddock - population numbers at age (x10⁻⁶) and F's.

| Age | 1965 | 1966 | 1967 | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 |
|-----|-------|-------|------|------|------|------|------|------|------|--------|--------|
| 2 | 162.0 | 14.2 | 8.3 | 14.1 | 7.3 | 12.3 | 21.9 | 4.0 | 38.3 | (22.0) | (10.0) |
| 3 | 61.5 | 132.5 | 11.4 | 6.8 | 10.9 | 6.0 | 9.1 | 17.2 | 3.2 | 28.6 | (17.5) |
| 4 | 12.0 | 47.6 | 91.9 | 8.9 | 5.3 | 7.1 | 4.2 | 6.0 | 11.0 | 2.5 | 19.2 |
| 5 | 11.1 | 8.0 | 30.1 | 56.8 | 6.2 | 2.5 | 4.5 | 2.7 | 3.2 | 7.0 | 1.8 |
| 6 | 16.2 | 6.2 | 3.7 | 16.4 | 30.7 | 3.6 | 1.7 | 2.4 | 1.8 | 1.7 | 4.1 |
| 7 | 5.0 | 8.4 | 3.2 | 2.1 | 9.2 | 15.0 | 2.5 | 1.1 | 1.4 | 1.0 | 0.9 |
| 8 | 2.5 | 2.3 | 3.5 | 1.9 | 1.1 | 4.6 | 8.2 | 2.0 | 0.8 | 0.6 | 0.6 |
| 9 | 1.9 | 1.1 | 1.1 | 1.9 | 1.1 | 0.4 | 2.1 | 3.7 | 1.6 | 0.4 | 0.2 |
| 10 | 0.7 | 0.9 | 0.5 | 0.8 | 0.9 | 0.7 | 0.2 | 0.8 | 2.0 | 1.0 | 0.1 |
| 11 | 0.5 | 0.3 | 0.3 | 0.3 | 0.4 | 0.6 | 0.5 | 0.1 | 0.2 | 1.0 | 0.6 |

| | | | | | | | | | | | |
|----|-----|-----|-----|-----|-----|-----|------|------|-----|-------|-------|
| 2 | .00 | .02 | .00 | .05 | .00 | .10 | .04 | .01 | .09 | (.03) | (.27) |
| 3 | .06 | .17 | .05 | .05 | .23 | .14 | .22 | .25 | .04 | .20 | (.34) |
| 4 | .20 | .27 | .28 | .16 | .53 | .27 | .23 | .42 | .26 | .14 | (.35) |
| 5 | .38 | .58 | .41 | .42 | .34 | .18 | .43 | .23 | .45 | .33 | (.35) |
| 6 | .46 | .48 | .37 | .38 | .52 | .18 | .30 | .36 | .39 | .41 | (.35) |
| 7 | .57 | .68 | .30 | .48 | .49 | .41 | .03 | .10 | .66 | .24 | (.35) |
| 8 | .60 | .52 | .41 | .35 | .65 | .60 | .60 | .03 | .61 | .72 | (.35) |
| 9 | .57 | .52 | .20 | .50 | .28 | .40 | .79 | .43 | .20 | .88 | (.35) |
| 10 | .60 | .77 | .23 | .33 | .26 | .17 | 1.31 | 1.32 | .43 | .33 | (.35) |
| 11 | .64 | .37 | .36 | .54 | .56 | .40 | 0.55 | 0.75 | .44 | .87 | (.35) |

Table 5. Div. 4X haddock catch projections.

| Age | Mean wt. (kg) | Partial rec. | 1975 Popn. No. (10 ⁻⁶) | 1975 catch Wt (mt) | 1976 catch Wt (mt) | 1977 catch Wt (mt) | 1978 catch Wt (mt) |
|--|---------------|--------------|------------------------------------|--------------------|--------------------|--------------------|--------------------|
| 2 | 0.52 | 0.77 | 10.0 | 1,118 | 1,638 | 1,960 | 1,072 |
| 3 | 0.82 | 0.97 | 17.5 | 3,765 | 1,165 | 2,099 | 2,681 |
| 4 | 1.24 | 1.00 | 19.2 | 6,409 | 2,951 | 1,130 | 2,171 |
| 5 | 1.99 | 1.00 | 1.8 | 964 | 5,141 | 2,932 | 1,197 |
| 6 | 2.39 | 1.00 | 4.1 | 2,638 | 579 | 3,823 | 2,325 |
| 7 | 2.95 | 1.00 | 0.9 | 715 | 1,627 | 442 | 3,115 |
| 8 | 2.97 | 1.00 | 0.6 | 480 | 360 | 1,014 | 294 |
| 9 | 3.31 | 1.00 | 0.2 | 178 | 267 | 248 | 746 |
| 10 | 3.32 | 1.00 | 0.1 | 89 | 89 | 166 | 164 |
| 11 | 3.38 | 1.00 | 0.6 | 546 | 45 | 56 | 112 |
| Total calculated catch | | | | 16,904 | 13,862 | 13,870 | 13,876 |
| Corrected catch | | | | 18,273 | 15,000 | 15,000 | 15,000 |
| Fishing mortality (F) | | | | 0.35 | 0.30 | 0.30 | 0.33 |
| Biomass age 4+ | | | | 44,500 | 47,500 | 41,500 | 39,000 |
| Recruitment at age 2 (x 10 ⁻⁶) | | | | 10.0 | 17.0 | 20.0 ¹ | 10.0 ² |

¹ Based on USA survey catch at age 0 in 1975.

² Arbitrary value.