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An Assessment of Yellowtail Flounder in NAFO Div. 3LNO

by

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INTRODUCTION

TAC regulation

This stock has been under quota regulation since 1973, when a precautionary TAC of 50,000 t was set. In 1976, the TAC was set at 9,000 t, following a rapid decrease in the stock biomass. Since then, the TAC has been set between 12,000 and 23,000 t, with 15,000 t representing the level in 1985 and 1986 (Table 1).

Catch history

The nominal catch of this stock increased from a few hundred tons in the early 1960's to a high of 39,000 t in 1972 (Table 1, Fig. 1). In the period up to 1975, USSR and Canadian vessels took virtually all the catch, however, Canada was the only country with significant catches from 1976 to 1981. Since 1981, however, catches from other countries, notably South Korea, have been increasing, with the result that the 1985 catch of 27,000 t is the highest since 1973. This represents an increase of 80% over the 1984 catch, and exceeds the recommended TAC by more than 12,000 t.

Several points are worth noting regarding the nominal catches since 1982:

a) South Korea reported catches of "flounder non-specified" to NAFO in 1982-83. These catches, along with those from the same country in 1984-85, were estimated to contain 60% yellowtail and 40% American plaice, by weight, based on inspections of catch by Canadian authorities.

b) The estimated catch of 11,000 t by "other" countries in 1985 (Table 1) is broken down as follows: U.S.A. 3,800 t, Panama 4,100 t, Cayman Islands, 700 t and Spain 2,400 t.

c) Catches for South Korea 1984-85 and "others" (with the exception of the Spanish and the U.S.A. catch in 1985) (Table 1), were based on estimates of catch per day and total days fished made by Canadian surveillance officers.

d) South Korean catches, 1982-85 and the "other" catch 1985, were taken outside the Canadian 200 mile limit. Ninety percent of these catches were assumed to come from Div. 3N, based on surveillance reports and the amount of suitable yellowtail fishing grounds located outside the 200 mile limit in Div. 3N, compared to Divs. 3L and 3Ø.

The majority of catches from this stock have come from Div. 3N (Table 2), with the 1985 catch of 21,000 t being the highest in this division since 1973. Catches from Div. 3L have averaged about 2,800 t per year since 1976, while catches in 3Ø were usually in the 600-2,000 t range over the same period.

Most of the Canadian landings in recent years have come from stern otter trawlers (TC 5), usually in conjunction with the American plaice fishery on the Grand Banks. South Korean catches have been taken by larger factory freezer trawlers and U.S.A. catches in 1985 were taken by small otter trawlers from the New England States. In most years, catches occur in all months (Table 3), with peak catches often coming in the fall. Accurate monthly breakdowns for most of the catch outside the 200 mile limit by non-Canadian vessels are not available.

Catch and effort

Catch and effort information from Canadian trawlers in the main species yellowtail fishery is shown in Table 4. CPUE declined from a level of 0.6 t/hr in the early 1970's to .33 t/hr in 1976, then increased to over 0.6 t/hr in 1980-81. Since then, catch rates have been stable at around 0.55 t/hr (Fig. 2). Since 1982, about half the Canadian catch has come from the directed (main species yellowtail) fishery, with the remainder being taken as by-catch, primarily in the American plaice fishery. With the increase in total catch in 1985, calculated effort, based on Canadian CPUE, increased from 27,000 hours in 1984 to 48,000 hours in 1985.

ASSESSMENT

Sampling

Length frequency information and otolith collections were available from the Canadian catch in 1985. The sampling level for this segment of the fishery in 1985 was good (Table 5), as has been the case in all recent years. Unfortunately, no sampling was available from the catch by other countries with the exception of one length frequency from a U.S.A. catch.

Numbers caught at age

For 1985, these were obtained in the usual way by applying quarterly age-length keys (sexes separate) to monthly length frequencies for each NAFO division. Total catch at age was then obtained by combining male and female numbers at age from Divs. 3L, 3N, and 3Ø. Table 6 shows the catch at age in 1985 and Tables 7 and 8 show the catch numbers at age and proportions at age respectively for 1968-84. It should be noted that the catch at age for 1982-84 was adjusted upward to reflect landings which were not previously included in calculating the catch at age. These adjustments were, in order from 1982 to 1984: 1.145, 1.129, and 1.194.

The catch at age in 1985 was similar to that observed in 1984 (Tables 7 and 8), with age 6 and 7 contributing over 77% to the total catch in numbers. The 1978 year-class again showed up strongly, contributing 47% of the total catch at age in 1985, the highest value for a year-class at age 7 in the entire series (Table 8). In the 1982-85 period, this year-class also showed up stronger in the commercial fishery at ages 5 and 6 than any other year-class. The catch proportion of yellowtail aged 4 and 5 has declined since 1981, possibly reflecting an increase in discarding, which Stevenson (1983) noted for the Grand Banks American plaice stock in the 1980-82 period. Because there is no information available on discarding in this stock, it should be noted that the catch at age reflects landings only, and not removals. It should also be noted that sampling was available for only the Canadian commercial catch in 1985, with the result that there is no information on the catches by other nations, which comprise about 50% of the total landings (Table 1). Therefore, the assumption that the total catch at age in 1985 would resemble that of the Canadian fleet may not be accurate, given that virtually all of the unsampled catch came from the fishery on the tail of the bank, outside the Canadian 200 mile limit.

Weights at age

These were determined in the usual manner, using the method described in Brodie, 1985. The average weights for 1986 are presented in Table 6 and the weights for 1968-86 are shown in Table 9. It can be seen from the latter table that the weights in 1985 are very close to those calculated in 1984 and indeed close to those observed in most recent years. However, the previously noted problems with the large portion of unsampled catch are important when considering possible sources of error in the 1985 weights at age.

Table 10 contains the calculated catch biomass for 1968-85. These values are within 13% of the nominal catches for this stock in all cases, and in most years are within 6%.

Natural mortality (m)

There has been considerable discussion in recent assessments of this stock on appropriate levels of natural mortality. Total mortality (Z) estimates from various sources on the older (7+) ages are usually in the 1.0-2.0 range, even in the earlier years when less exploitation occurred. Although the species has a short life span, both on the Grand Banks and off the northeastern U.S.A. (where m for yellowtail is set at 0.2), there has been no documented reasons (i.e. spawning mortality, emigration, exploitation) for the unusually high mortalities observed at the older ages. Consequently, the value of m = 0.3, used in previous assessments of this stock, is retained for all age groups.

Research vessel survey data

Stratified-random trawl surveys have been carried out by Canadian research vessels on the Grand Banks in the spring of the year since 1971. The results of these surveys, in the form of mean weight per tow by stratum, along with total biomass estimates are given in Tables 12-14 for Div. 3L, 3N, and 3Ø respectively. Figure 3 shows the depth stratification scheme used in these surveys.

The most recent assessment of this stock contains a detailed account of the Canadian survey series. For information on such aspects as effects of changing vessels on survey estimates; consistency of survey coverage over time, and rationale for selecting particular strata for comparison of biomass and abundance between years, see Brodie 1985.

It can be seen from Tables 12-14 that the majority of the biomass of this stock is found in Div. 3N, in strata on or near the Southeast Shoal (strata 375, 376; Fig. 4). Examination of the 1977-85 survey data revealed that less than 1% of the yellowtail biomass in Div. 3L is estimated to be outside the Canadian 200 mile limit, while the figures ranged from 22 to 40% for Div. 3N and 0 to 5% for Div. 3Ø. These estimates were obtained by assuming the calculated biomass outside the 200 mile limit in each appropriate stratum was the same proportion of the total stratum biomass as was the area of the stratum outside the 200 mile limit of the total stratum area. Based on the estimates for Div. 3N, it is obvious that a significant portion of the total stock is outside the 200 mile limit.

Table 15, which shows survey information from the selected strata in Div. 3L and 3N, 1971-86, suggests a relatively stable population from 1978 to 1982. There was no survey in 1983 and the 1984 estimates were higher than those in 1982. However, the 1985 and 1986 surveys both indicate population biomasses close to those observed in the 1978-82 period.

Tables 16-19 contain age by age information for the selected strata from the Canadian survey series from 1971 to 1985. Tables 16 and 18 show the actual data in terms of average number per set and total abundance respectively while Tables 17 and 19 show the same data, adjusted for differences in fishing power of the vessels involved in the surveys (Gavaris and Brodie, 1984). The apparent stability of the population size and structure since 1978 is obvious from Table 19. As was postulated in Brodie, 1985, the high estimates observed in 1984 appear to be anomalous, as evidenced by the population sizes estimated in 1985 and 1986. As noted in the information from the commercial fishery, the surveys show that the 1978 year-class appears to have been strong, comparing it to other recent year-classes at ages 4, 6, 7 (Table 17).

As can be seen from Tables 16-19, yellowtail do not appear to be fully recruited to the survey trawl gear until age 7. Fish of ages 1 and 2 are absent from catches in most years, and ages 3 and 4 often are present only in very low numbers. Thus it is not possible to use this data to obtain reliable estimates of recruitment to the commercial fishery, where 4 is usually the age of first capture.

Partial recruitment (PR)

The same PR values proposed for the 1984 catch at age (Brodie 1985) were used again in this assessment. These values, along with other PR vectors used for this stock, are shown in Table 11. The current PR was derived from average fishing mortalities in an earlier period, and an account of how this vector was derived can be found in Brodie 1985. Given the reduced proportion of age 6 fish in the catch numbers at age in 1985 compared to 1984, there may be cause for concern that the PR at age 6 in 1985 is overestimated. In any case, the vector labelled PR 4 in Table 11 was used to run the cohort analyses presented later in this paper.

Sequential population analysis (SPA)

As has been noted in many previous assessments of this stock, a pattern of very high mortalities at ages 7+ emerges from SPA. It has also been noted that cohort analysis (as well as research surveys) has shown that the stock size has increased since the mid 1970's. Therefore, it has been hypothesized that such large values of F, often greater than 1.5, are not likely to have occurred in as many instances as indicated by SPA and that these high mortalities at the older ages may be due to some other factor (e.g. natural mortality). In any case, it is still possible to calibrate SPA over a reasonable range of fishing mortalities, using both commercial and research vessel abundance indices. The last two assessments, however, have not used output from an SPA as the basis for stock projections, although it was agreed that the SPA "was useful for indicating trends in population size" (NAFO Redbook, 1985).

It is obvious from Table 10 that ony 3 ages (6, 7, 8) contribute in a significant way to the catch. For example, these 3 ages constituted between 89 and 95% of the catch weight in 1983 to 1985. It follows from this that the population sizes at ages 4, 5, and 6 in 1985 are crucial to the assessment of this stock, these being the year-classes which will form the bulk of the fishery in 1987. The fully-recruited age groups in 1985 (7-10) will probably contribute less than 10% to the catch in 1987, making the accurate determination of their size in 1985 somewhat less of a priority. For these reasons, attempts were made in this assessment to calibrate the cohort analysis on an age by age basis using research vessel survey data. However, this was not successful for age 4 fish, the probable reasons being the low recruitment of this age to the survey gear and the high discard rate thought to exist in the commercial fishery for this age. Also, for reasons discussed previously, there was little point in attempting these calibrations with age 7+ fish, given their relative unimportance to the forecasted 1987 catch. Consequently, the age by age calibrations were carried out using ages 5 and 6 only.

Table 20 shows the results of the SPA calibration, using 5+ biomass vs CPUE and 5+ weighted F vs effort as well as the age 5 and 6 cohort numbers vs survey numbers. Cohort analyses were run at levels of terminal F (F_t) in 1985 ranging from 0.8 to 1.2, using the partial recruitment values noted previously. The results from this table are summarized as follows:

1) Age 5 cohort nos. vs Age 5 survey nos. per tow (from Table 17). These regressions gave correlation coefficients (r) in the 0.60-0.68 range, increasing in the SPA runs from F_t = 0.8 to F_t = 1.1. Based on minimizing the 1985 residual (observed minus calculated), F_t would be below 0.8; however, the regression becomes non-significant at F_t = 0.6. Based on minimizing the sum of the 1985 and 1984 residuals, F_t would be between 0.8 and 0.9 (given that PR at age 5 = 0.071), indicating a population size of about 42 million at age 5 in 1985.

2) Age 6 cohort nos. vs Age 5 survey nos. per tow (Table 17). These regressions indicated r to be increasing from 0.67 at F_t = 0.8 to 0.82 at F_t = 1.2. Both the 1985 and the 1985+1984 residuals remain positive over this range, indicating a population size at age 6 in 1985 of 40 million or slightly less.

3) Age 5+ average biomass vs CPUE (from Table 4). These regressions were barely significant at the .05 level. They showed that the 1985 residual was minimized at F_t close to 0.9, while the 1985+1984 residual was lowest at F_t between 1.0 and 1.1.

4) Age 5+ fishing mortality weighted by cohort population nos. vs fishing effort (Table 4). These regressions gave excellent r values (approximately 0.82) but showed minimal difference in r over the range of F_t tried. Based on the 1985 residual alone, F_t is between 0.8 and 0.9 and based on the sum of the 1985 and 1984 residuals, F_t is between 0.9 and 1.0.

Based on the above, the run at F_t = 0.9 was chosen as the best estimate. It should be pointed out that this is much higher than the $F_{0.1}$ value of 0.52 for this stock, which is not surprising, given the fact that the estimated 1985 catch exceeded the recommended TAC by 83%. The results of cohort analysis at this level of F_t are shown in Table 21. Plots of the above relationships used to calibrate the analysis, for the run at F_t = 0.9, are shown in Fig. 5-8.

Catch projections

Once again, it was decided that the cohort analyses contained too many uncertainties to use the results as the basis for catch projections.

CONCLUSIONS

The cohort analyses indicates a relatively stable stock size in recent years. However, it must be noted that the increase in catch in 1985 was due to increased effort and hence fishing mortality, rather than an increase in abundance. Given current information on stock status and recruitment and examining the catches of this stock throughout the 1970's, it is unlikely that this stock can sustain catches of close to 30,000 t for an extended period. With most abundance indices pointing to recent stock size stability, it is recommended that the TAC of 15,000 t be kept in place for 1987.

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