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Commercial Fishery Based Esitmate of Cod and Haddock Abundance on Georges Bank

by

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[1]This series documents the scientific basis for the evaluation of fisheries resources in Atlantic Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

Research documents are produced in the official language in which they are provided to the secretariat.

[1]La présente série documente les bases scientifiques des évaluations des ressources halieutiques sur la côte atlantique du Canada. Elle traite des problèmes courants selon les échéanciers dictés. Les documents qu'elle contient ne doivent pas être considérés comme des énoncés définitifs sur les sujets traités, mais plutôt comme des rapports d'étape sur les études en cours.

Les Documents de recherche sont publiés dans la langue officielle utilisée dans le manuscrit envoyé au secrétariat.

Abstract

The commercial landings data from 1987-1992 were used to produce abundance estimates for the Georges Bank cod and haddock stocks. The data used in the analysis were restricted to records from otter trawlers that were allocated quotas for these target species in 1992, and had records in at least four years of the time series. Furthermore, this subset of the catch data was standardized to a common vessel, year, month and NAFO area.

The trends in abundance indicate all time lows for cod and haddock in the last three years of the series. The estimated effort also declined dramatically in the last year, perhaps as a result of low cod and haddock numbers.

Résumé

On s'est servi des données sur les débarquements commerciaux de 1987 à 1992 pour produire des estimations d'abondance des stocks de morue et d'aiglefin du banc Georges. Les données en question provenaient uniquement de chalutiers à panneaux qui avaient reçu des quotas pour ces espèces cibles en 1992 et à propos desquels on disposait de statistiques sur au moins quatre années de la série chronologique. En outre, on a standardisé ce sous-ensemble de données pour un même bateau, un même mois, une même année et une même zone de l'OPANO.

Il ressort de l'analyse des tendances que l'abondance de la morue et de l'aiglefin a atteint son niveau historique le plus bas dans les trois dernières années de la série. L'effort éstimé a aussi chuté considérablement la dernière année, en raison peut-être du petit nombre de morues et d'aiglefins.

Introduction

The estimation of species abundance is ideally based on random samples collected by a standard vessel in an unbiased way. The commercial landings data are a source of fisheries data that suffers from being collected in a biased, non-random manner by a variety of vessels. These shortcomings are no surprise since the primary use of the commercial landings data has been catch monitoring. However, with the application of a standardization technique useful abundance estimates can be derived.

The Georges Bank cod and haddock fishery represent a relatively small subset of the commercial landings. Nevertheless, the standardization procedure applied to even a short time series can quickly exceed the capacity of the system if it is not restricted in some way. This report describes a method of data selection and standardization that provided low variance estimates of Georges Bank cod and haddock abundance.

Methods

Data selection

The commercial landings data base thoroughly characterizes a vessel's catch on either a set, day or trip level. Variables include vessel characteristics (eg. tonnage, horsepower), gear type (eg. handline, purse seine), species, weight, date, effort and location. From this list, variables thought to introduce the most variation in the catch rate were considered.

Vessel/Gear

The gear type was restricted to the stern otter trawl because the definition of effort for this gear is similar for all vessels using it. The source of vessels in this study was the ITQ listings for 1992. From this table, vessels with ITQ's for cod or haddock in unit areas 5Zjm greater than one tonne were used (approximately 188 vessels from tonnage class 1-3). The number of vessels was further reduced by eliminating the infrequent users of the fishery. That is, vessels with no cod landings for three or more years between 1987 and 1991 were eliminated; while for haddock, vessels with no landings in two or more years were dropped. Participation in 1992 was not a factor because these data were not available until a very late date. Of the 188 vessels, 102 were retained for cod and 51 for the haddock fishery. These vessel reductions did not alter the trend in the estimated catch rate and improved the precision of the estimates.

Years/Months

The time series extends from 1987 to 1992. The level of aggregation for catch within each year changed over this time period. The earlier data merely summarized the catch for a vessel's trip, whereas the more recent years have set level information. These changes in the level of aggregation of the catch and effort data since 1987 dictated how the more recent data would be processed and whether or not it would be feasible to extend the time series earlier than 1987.

Estimates of catch rate at the different levels of aggregation were consistent when all cod or haddock landings from the short list of vessels was used. Thus, trip level estimates were proportional to set or day level estimates . Consequently, trip-level data could be used resulting in both a further reduction in the number of records and compatibility with the early data because of the use of a consistent level of aggregation.

The months fished were restricted to June through to September. This period corresponded to times when the vessels of interest registered the bulk of their landings.

Landed weight/Effort hours

All records, where either the landed weight or effort hours equalled zero, were excluded. An inconspicuous feature of the data was that the weight for a catch was often partitioned according to the form (round, gutted) in which it was landed, whereas the corresponding effort was not. If this situation were not remedied, many invalid occurrences of low catch rate would be evident, biasing abundance estimates downwards. Consequently, these split records were summed for values of landed weight only, not effort hours.

The trip level aggregation of the data left two alternatives for representing the catch rate of a vessel's trip. Catch rate in this study was represented by the ratio of the sum of the catch to the sum of the effort rather than the average catch rate for a trip. The former method tends to dampen the effect of extreme values.

Catch rate standardization

The ability to catch cod or haddock was thought to differ among different regions (NAFO areas in this study), vessels, years and months of the year. In fact, there are probably interactions among these factors which contribute to variation in catch rate. The importance of these interactions will be the topic of further study. The present analysis addressed the significance of the main effects only, where a multiplicative model (as outlined by Gavaris 1980) was used to describe the relationship between catch rate and the above factors.

Results

Figure 1 and Table 1 indicate that haddock abundance has remained low since 1990 and that the effort directed towards this stock has begun to decline. The increased misreporting of haddock catch from 4X to 5Zjm observed in 1992 could elevate that year's abundance estimate, however, those vessels known for this practice were not present in the analysis.

Cod abundance is shown to oscillate downwards from 1987 onwards (Fig. 2, Table 2). The estimated effort was quite high in 1990-1991 when stocks were low but is seen to decline in 1992, perhaps in response to low cod abundance in 1991.

The analyses of variance, based on the multiplicative model of cod and haddock catch rates (Table 3 & 4), show strong month and year effects. Vessel effects, although smaller, were significant for both species. Unit area accounted for a significant amount of variation in cod catch rate only. The amount of the total variation in catch rate attributed to regression, while generally low, also larger for cod (37.7% versus 21.3%). The inclusion of new factors or the interaction between factors may help to account for more of the total variation and thereby improve the standardization of catch rate.

The regression parameter estimates associated with months and areas, termed powers, represent the conversion ratio of category types relative to a standard category. These powers are a useful tool for comparing categories. For example, the relative fishing power of months suggest that haddock are more easily caught in June and September and cod in June and July. Haddock are fished mostly in 5Zj, although the fishing power for 5Zj does not differ markedly from that of 5Zm. Cod are also fished more heavily in 5Zj but in this case are also caught more easily in 5Zj than in 5Zm. In both fisheries, an increasing amount of effort is being directed towards area 5Zm.

References

Gavaris, S. 1980. Use of a multiplicative model to estimate catch rate and effort from commercial data. Can. J. Fish. Aquat. Sci. 37:2272-2275.

Table 1. Estimated catch rate (t/hr) and effort (hr) using *one vessel, area 5Zj and July as the standard.* The observed catch (t) for haddock by tonnage class 1-3 trawlers.

Year	CPUE	S.E.	Catch	Effort
1987	0.290	0.080	2230	7689
1988	0.381	0.106	2547	6683
1989	0.403	0.127	1062	2633
1990	0.151	0.041	1788	11810
1991	0.146	0.040	3339	22077
1992	0.169	0.047	1704	10089

Table 2. Estimated catch rate (t/hr) and effort (hr) using one vessel, area 5Zj and July as the standard. The observed catch (t) for cod by tonnage class 1-3 trawlers.

Year	CPUE	S.E.	Catch	Effort
1987	0.621	0.118	7608	12243
1988	0.453	0.087	7620	16838
1989	0.323	0.068	1987	6152
1990	0.369	0.069	7854	21287
1991	0.226	0.042	6698	29662
1992	0.331	0.063	4844	14647

Table 3. Analysis of variance for a main effects multiplicative model, for catch rate of cod on Georges Bank.

Source of variation	Degrees of freedom	Sum of squares	Mean squares	F-value
Intercept	1	9.245E3	9.245E3	
Regression	110	1.152E3	1.047E1	13.061*
Vessel	101	4.898E2	4.849E0	6.049*
Area[1]	1	4.620E1	4.620E1	57.635*
Month	3	2.111E2	7.037E1	87.793*
Year	5	2.532E2	5.063E1	63.161*
Residuals	2370	1.900E3	8.016E-1	
Total	2481	1.230E4		

[1]Unit areas 5Zj and 5Zm.
*P<0.01.
Multiple R=0.614 Multiple R squared=0.377

Table 4. Analysis of variance for a main effects multiplicative model, for catch rate of haddock on Georges Bank.

Source of variation	Degrees of freedom	Sum of squares	Mean squares	F-value
Intercept	1	1.159E4	1.159E4	
Regression	59	5.622E2	9.529E0	6.036*
Vessel	50	3.161E2	6.322E0	4.004*
Area[1]	1	1.541E0	1.541E0	0.976
Month	3	9.177E1	3.059E1	19.375*
Year	5	1.607E2	3.214E1	20.357*
Residuals	1312	2.071E3	1.579E0	
Total	1372	1.422E4		

[1]Unit areas 5Zj and 5Zm.
*P<0.01.
Multiple R=0.462 Multiple R squared=0.213

Fig. 1. Standardized CPUE generated for an otter trawler fishing for haddock in 5Zj in July.

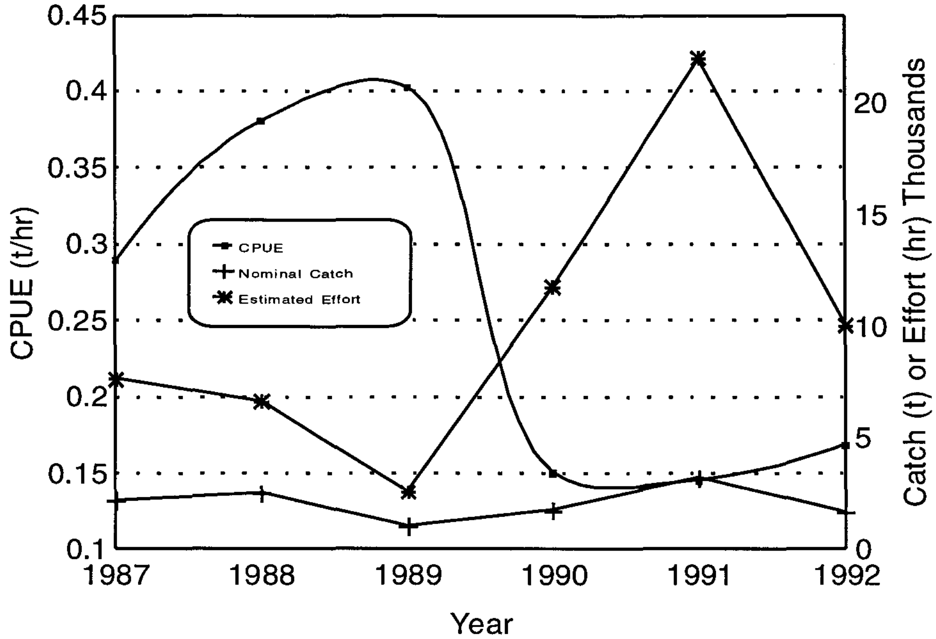

Fig. 2. Standardized CPUE generated for an otter trawler fishing for cod in 5Zj in July.