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Standardized CPUE Indices for Greenland Halibut and American Plaice in NAFO Divisions 3LMNO Based on Spanish Commercial Catch Rates

by

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Abstract

Standardized cpue series using a Generalized Linear Model for Greenland halibut and American plaice in Division 3LMNO, based on catch and effort data from the Spanish trawl fleet since 1990 at depth intervals are presented. In the case of the Greenland halibut series, the largest proportion of the variance (45%) is explained by the factor 'depth', while in the American plaice on it is the factor 'vessel' (51%). The general trend observed in the Greenland halibut standardized CPUE in all divisions is a sharp increase in the indices from about 600 m, attaining maximum values between 900-1 000 m, and then decreasing at depths beyond 1 200 m. American plaice CPUE values at depths less than 500 m are very small in all divisions. The American plaice cpue series show two peaks one between 100-200 m. and the other between 400-500 m, decreasing sharply thereafter. The larger values in this species are observed in Div. 3L and 3N, while very small ones are in Div. 3M at any depth.

Introduction

The Spanish Greenland halibut fishery in Div. 3LM Regulatory Area is performed by bottom trawlers since 1990 (Junquera et al., 1992). From about 1993 the activity of this fleet spread to the south, into Div. 3N and 3O shelf edge, where at present a significant proportion of this fleet effort is displayed (Junquera et al., 2000). In recent years concerns raised because of the possible overlapping between the Greenland halibut fishery, as it is performed at present, and other shelf stocks under moratoria in the Grand Bank, mainly American plaice, whose depth range of distribution in this area is now known to extend deeper that previously thought, at least in some seasons.

In this paper standardized cpue series for Greenland halibut and American plaice in Div. 3LMNO based on catch and effort data from the Spanish trawl fleet since 1990 at depth intervals are presented. Since Greenland halibut is the target species of this fleet, the standardized cpue data can be considered as an index of the fishable biomass depth distribution. According to previous results (Junquera et al., 2000; Kulka et al., 2001) American plaice should not be considered a target species for this fleet, but still in this case the standardized index can illustrate the likely magnitude of the 'true and unavoidable by-catch' of this species that can be expected to occur in the Greenland halibut fishery in relation to depth.

Materials and Methods

1- Catch and effort data.

Records of catch and effort data from the Spanish Greenland halibut fishery was collected since 1990 in Div. 3LMNO by scientific observers from the national sampling program. While those records varied in coverage over the years, it is assumed that the available data are representative of the fishery, considering that the Spanish fleet catches constitute the major component of the total Greenland halibut catch in the Regulatory Area. Data are recorded on a haul-by-haul basis and were condensed to the month and the trip level, to provide total weight of the species and total hours of fishing per vessel, area and month. Catch per hour was the unit measure selected to standardize the series.

2- Standardizing method.

A generalized linear model (McCullagh and Nedler, 1983; Cook, 1997) have been applied to the catch and effort data. This method is appropriate for standardizing cpue indices, as it can account for the variability resulting from significant year and other factors interactions in the standardization procedures of catch and effort data. The fitted cpue values obtained are based on a linear function of fixed factors and random effect interactions to take into account possible correlations between observations. The theoretical background of the generalized linear models have been developed by Nelder and Wedderburn (1972). Those models are generalizations of the common linear regression models to situations where the response is discrete or varies in other ways from the standard linear models assumptions.

The Gaussian model formulation with an identity function to link the linear factor components and the error distributions have been used, as it proved to fit adequately to the observed data. A stepwise procedure was used to determine the factors and interactions that significantly explain the observed variability. To do this the fixed factors considered are: year, month, vessel, depth and area. The interactions analysed are: year – month, year – vessel, year – area, vessel – depth, vessel – year and vessel – area.

The bottom row of Table 1A and B have been used as model specifications for obtaining for standardizing cpue series for both species. Then the factor 'depth' have been selected as main factor for obtaining fitted cpue values at depth, and a weighting by the inverse of the variance have been applied. This analysis have been performed using the S-plus program.

Results

The results of the step-wise regression analysis used to determine the specifications for standardizing cpue series are listed in Table 1 (A) for Greenland halibut and 1 (B) for American plaice. In each of the tables, the residual deviance column means the deviance from the observed data at each of the steps. In the case of the Greenland halibut series, the largest proportion of the variance (45%) is explained by the factor 'depth' alone, but the interaction between the factor 'vessel' with 'depth' and 'area' also have a large contribution (18 and 14% respectively). The total proportion of variance explained by this model is 82%. In the case of the American plaice, the largest proportion of the variance (51%) is explained by the factor 'vessel' alone, and the total proportion of the variance explained by this model is 75%.

The Greenland halibut standardized CPUE by depth intervals are illustrated in Fig. 1. The general trend observed in all Divisions is a sharp increase in the CPUE indices from about 600 m, attaining maximum values between 900-1 000 m, and then decreasing at depths beyond 1 200 m. CPUE values at depths less than 500 m are very small in all divisions. Those results are in agreement with the ones from previous analysis (Junquera et al., 2000).

The American plaice cpue series by depth intervals in Div. 3LNO and in all Divisions combined (Fig. 2) show two peaks one between 100-200 m. and the other between 400-500 m, decreasing sharply thereafter. The larger values are observed in Div. 3L and 3N, while very small ones are in Div. 3M at any depth.

According to those results can be concluded that the Greenland halibut fishable biomass mainly occurs at depths beyond 600 m, while the one on American plaice occurs at depths shallower than 500 m. Though American plaice catches still can be expected beyond 600 m, particularly in Div. 3N, which is the threshold from where Greenland halibut catch rates start to increase, CPUE trends in both species are exactly opposite and so the deeper the fishery would be performed, the smaller would be the American plaice catches.

References

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Table 1. Summary of the results of the step -wise analysis for determining the specifications for standardizing CPUE data using a Generalized Linear Model for Greenland halibut and American plaice in Div. 3LMNO (1990-2000). Y = year, M= month, V = vessel, D = depth, A= area (NAFO Division). Two points designates factors interaction. (*) not significant F value.

(A) Greenland halibut

Model factors	d.f.	Residual Deviance	Change in deviance	% of total deviance	Pr (F)
Null		2196			
Y	1	2183	13	1	0,00026
Y M	1	2138	45	3	0,00000
Y M V	56	1933	205	12	0,00000
Y M V D	1	1147	786	45	0,00000
Y M V D A	3	1074	73	4	0,00000
Y M V D A Y:M	1	1071	3	0	0,06237 *
Y M V D A Y:M Y:V	39	1033	38	2	0,50779 *
Y M V D A Y:M Y:V Y:A	3	1031	1	0	0,77365 *
Y M V D A Y:M Y:V Y:A V:D	56	716	316	18	0,00000
Y M V D A Y:M Y:V Y:A V:D V:M	55	685	31	2	0,99701 *
Y M V D A Y:M Y:V Y:A V:D V:M V:A	116	446	239	14	0,00000
		Total variance explained		**82**	

(B) American plaice

Model factors	d.f.	Residual Deviance	Change in deviance	% of total deviance	Pr (F)
Null		6369367			
Y	1	6130977	238390	1	0,00000
Y M	1	6063471	67506	10	0,00000
Y M V	56	5134546	928925	51	0,00000
Y M V D	1	4211104	923442	6	0,00000
Y M V D A	3	4120138	90966	4	0,00000
Y M V D A Y:M	1	4116749	3389	0	0,13927 *
Y M V D A Y:M Y:V	39	3586221	530528	13	0,00000
Y M V D A Y:M Y:V Y:A	3	3320302	265919	1	0,00000
Y M V D A Y:M Y:V Y:A V:D	56	2313442	1006860	4	0,00000
Y M V D A Y:M Y:V Y:A V:D V:M	55	2227777	85665	5	0,46419 *
Y M V D A Y:M Y:V Y:A V:D V:M V:A	116	1569712	658065	5	0,00000
		Total variance explained		**75**	

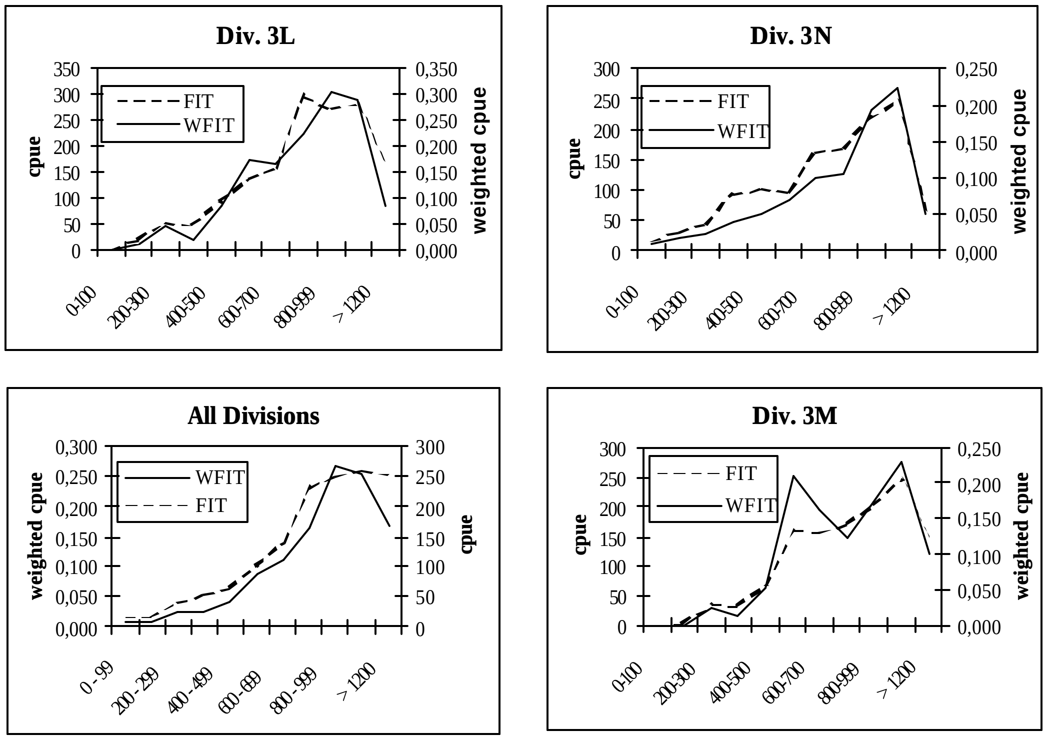

Fig. 1- Greenland halibut standardized CPUE series (FIT) by depth intervals and standardized series weighted by the inverse of the variance (WFIT).

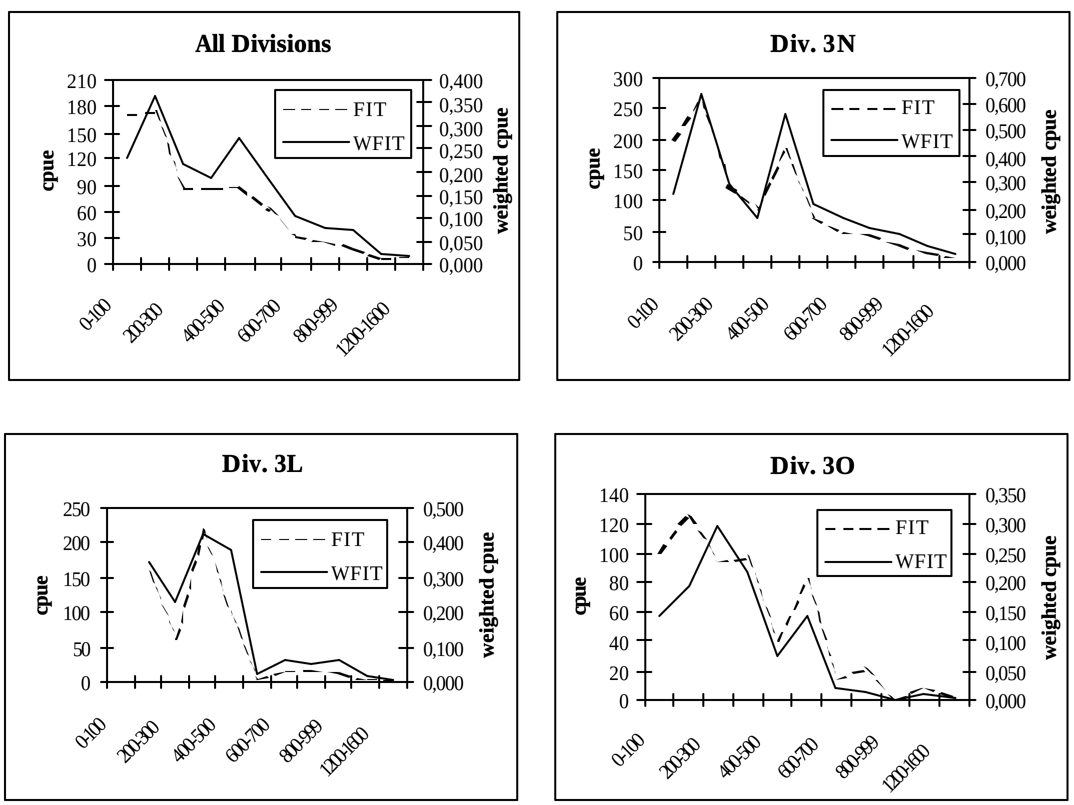

Fig. 2- American plaice standardized CPUE series (FIT) by depth intervals and standardized series weighted by the inverse of the variance (WFIT).