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Calculation of the Calibration Factors from the Comparative Experience between the R/V *Cornide de Saavedra* and the R/V *Vizconde de Eza* in Flemish Cap in 2003 and 2004

by

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Abstract

EU carries out a stratified random summer bottom trawl survey in Flemish Cap, Division 3M of the NAFO Regulatory Area, since 1988. Since 1991, the survey was made with the R/V *Cornide de Saavedra*. In 2003, this vessel was replaced for the R/V *Vizconde de Eza*, so, in order to maintain the series obtained from the old vessel, a two year comparative fishing trial between the two vessels was made in the years 2003 and 2004. This work presents the methods used for the transformation of the series and their results for biomass and length distribution for the principal species in the area: Atlantic cod, American plaice, Redfish (*Sebastes fasciatus*, *Sebastes marinus*, *Sebastes mentella* and *Sebastes juveniles*), Greenland halibut, Roughhead grenadier and Northern shrimp. For all the species except for Roughhead grenadier the R/V *Vizconde de Eza* is more efficient that the R/V *Cornide de Saavedra* for the biomass, with values of FPC varying between 1.0159 (Greenland halibut) and 1.4455 (Juvenile redfish). In lengths, in all species except for Roughhead grenadier too, the new vessel is more efficient catching the smallest individuals and less or equal efficient for the biggest lengths.

Material and Methods

The surveys on NAFO Regulatory Area of Div. 3M was initiated by EU in 1988. Until 2003, surveys were carried out in summer (July), on board the Spanish vessel R/V *Cornide de Saavedra* using bottom trawl net type *Lofoten* until a depth of 400 fathoms. Since that year, the survey is carried out by the *R/V Vizconde de Eza* using the same trawl net. For more details about the surveys, see Casas and González Troncoso, 2004.

R/V *Vizconde de Eza* replaced R/V *Cornide de Saavedra* in 2003 survey. The objective of this change is to improve the Greenland halibut indices of abundance and biomass. For this, it is necessary to reach bigger depths. Due to the impossibility of the R/V *Cornide de Saavedra* to fish in depths of more than 400 fathoms, it was necessary to change the vessel. In order to maintain the data series obtained since 1988, comparative fishing trials between the two vessels were conducted in summers 2003 and 2004 to develop factors between the two fishing vessels. A series of 130 paired hauls until 400 fathoms was carried out, 61 in 2003 and 69 in 2004; 111 of then were valid hauls in both vessels. Mean catch and biomass, with their respective standard deviations, and length distribution, were transformed from R/V *Cornide de Saavedra* series to R/V *Vizconde de Eza* series.

The distance during the trawls between the two vessels was the minimum possible, from 0.25 to 0.5 miles, depending of sea conditions. The relative position between the two vessels during the trawls (in starboard or port each of the other), was varying.

Although the fishing procedure in the new vessel was attempted to remain similar than in previous years, there are some differences in the fishing management as the trawl warp length as well as different characteristics of some fishing elements: trawl warp diameter, trawl winch control, presence or not of dan leno bobbin, that could modify the behaviour of the gear (geometry) and vary the catchability of some species. Also, the automatic system of the trawl winch in the new vessel maintains the same tension in the two trawl warps, heaving and setting out the adequate warp length, allowing to conserver the geometry of the gear and to optimise the yields in the bottom trawls.

To convert data series it was necessary to calculate the factor power correction (FPC), typically estimated by use of catch per unit of effort (CPUE) observations for the two vessels. In this case, a multiplicative model solved by generalized method by haul was adjusted to convert mean catch and biomass. Although there are many models to convert the CPUE, we choose one of them that has less error (Wilderbuer *et al*., 1998, González Troncoso and Paz, 2003).

Robson (1966) proposed the following multiplicative model to establish the relationship between the CPUEs for the two ships:

$$CPUE_{ij} = e^{\mu + t_i + h_j + \varepsilon_{ij}}$$

where: t_i is the effect of the ship i, $i = 1,2$

h_j is the effect of the haul j, $j = 1,...,90$

μ is the model parameter

ε is the model error

A logarithmic transformation is performed in order to obtain a linear expression:

$$\ln(CPUE_{ij}) = \mu + t_i + h_j + \varepsilon_{ij}$$

This equation was adjusted by generalized linear regression assuming the following restriction necessary to estimate all parameters:

$$\sum_{i=1}^{2} t_i = 0 \Rightarrow t_1 = t = -t_2$$

giving the following estimation of the FPC (Sissenwine and Bowman, 1978):

$$\widehat{FPC} = \frac{\widehat{CPUE_2}}{\widehat{CPUE_1}} = e^{2t(1+0.5s^2)} \qquad (1)$$

where s^2 is the variance obtained in the estimate of t.

In the other hand, to convert the length distribution, the following multiplicative model, proposed by Warren (1997) was adjusted:

$$Ratio = \alpha l^{\beta} e^{\delta l} \qquad (2)$$

where: $Ratio = \frac{Campelen\ Catch}{Pedreira\ Catch}$ by length

l is the length

$\alpha, \beta\ and\ \delta$ are the estimated parameters.

We use, in all cases, only the hauls in which both vessels had non cero catch.

Due to the low number of individuals caught in the extreme lengths, the ratios of those lengths appear too scatter, make the adjust so difficult. For this reason, an inferior and/or a superior ranges were taken in a subjective way when it was necessary. The correcting factor in these cases was taken as the mean of the ratio of the lengths in the range.

The method to convert the indices from the length distribution has no accurate variance. Besides this, as the fit is very poor in the extreme data, we must apply another parameters for the extreme lengths, and the cut points are choosing without objective criterion. Because of that, we do not consider this method as the best one for estimating the biomass indices.

Results

During the 22 days employed in the calibration experience, a total of 111 paired hauls were carried out. However, when we estimated the correcting factors, the number of valid hauls were appreciably reduced in some of the target species, due to the high number of hauls with catch 0 or outliers in some of the two vessels, that were not included in the analysis.

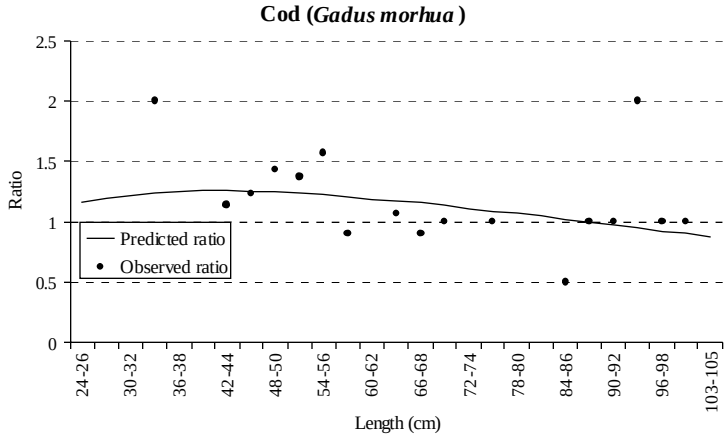
The results of the calibration of the principal species were the following:

Atlantic cod (*Gadus morhua*)

The Atlantic cod was present in 65 valid paired hauls, but it was present only in 38 of them in the two vessels. Of these, 7 were taken as outliers.

To convert the biomass, we adjust the method (1). The result of this adjust gave us a value of FPC=1.0998, that indicates that the new vessel, B/O *Vizconde de Eza,* is more or less 10% more efficient than the old vessel, B/O *Cornide de Saavedra*.

The ratios of the cod length distribution between the two vessels present no clear trend in the analysed range. To the low number of hauls we took into account, we must add the scarce number of individuals caught in these hauls; these facts made possible the presence of lengths with ratios that can be considered outliers (>3), that were removed from the analysis.



The result of the model (2) for Atlantic cod was the following:

$$\text{Ln(Ratio)} = \exp(-1.5582-0.0154\ln(l)+0.6501\,l)$$

The figure shows the ratios and their fit. In this figure, in the case of data below 25 cm., we observed that the fit is very poor, so the mean of the ratios was applied for this values. So two length classes were formed as follow (cf = conversion factor):

For $l \leq 24$: cf = 1.058
For $l \geq 25$: cf = $\exp(-1.5582-0.0154\ln(l)+0.6501\,l)$

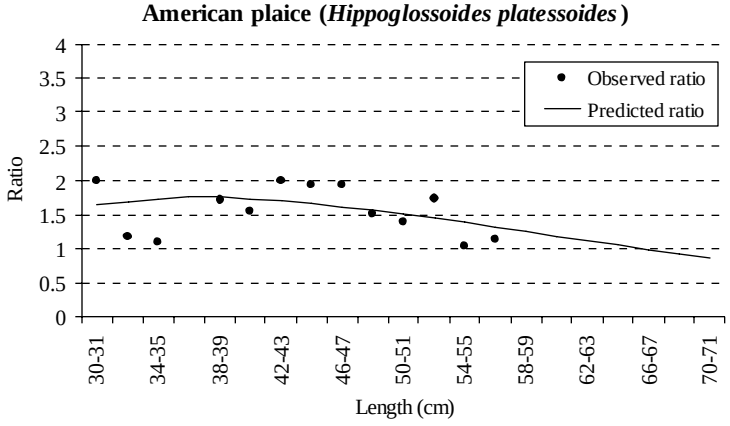
It seems that the new vessel is slightly more efficient for the smallest individuals and a bit less efficient in the biggest individuals.

American plaice (*Hippoglossoides platessoides*)

The American plaice was present in 81 valid paired hauls, but it was present only in 52 of them in the two vessels. Of these, 5 were taken as outliers.

To convert the biomass, we adjust the method (1). The result of this adjust gave us a value of FPC=1.3336, that indicates that the new vessel, B/O *Vizconde de Eza,* is more or less 33% more efficient than the old vessel, B/O *Cornide de Saavedra*.

The absence of American plaice individuals less than 22 cm in the catches of the two vessels do not let to know the efficiency of the new vessel for the smallest individuals. This fact is increasing by the dispersion of the ratios in the data below than 30 cm, with ratios considered outliers (>3).



The result of the model (2) for American plaice was the following:

$$\text{Ln(Ratio)} = \exp(-6.8366-0.0757\ln(l)+2.8232\,l)$$

The figure shows the ratios and their fit. In this figure, in the case of data below 34 cm., we observed that the fit is very poor, so the mean of the ratios was applied for this values. So two length classes were formed as follow (cf = conversion factor):

For $l \leq 34$: cf = 1.4192
For $l \geq 35$: cf = $\exp(-6.8366-0.0757\ln(l)+2.8232\,l)$

The length distribution adjust shows an efficiency of about the 50% more in the new vessel in the smallest lengths analysed, decreasing with the length until no differences in the biggest lengths.

Redfish (*Sebastes spp*)

Due to the impossibility to separate the three different species of *Sebastes* (*Sebastes fasciatus*, *Sebastes marinus* and *Sebastes mentella*) in the two vessels, the adjust and estimation of the correcting factors were made as if they were only a species. The individuals smaller than 16 cm were separated and analysed as a different species, as *Sebastes juveniles*.

The redfish was present in 108 valid paired hauls, but it was present only in 103 of them in the two vessels. Of these, 6 were taken as outliers.

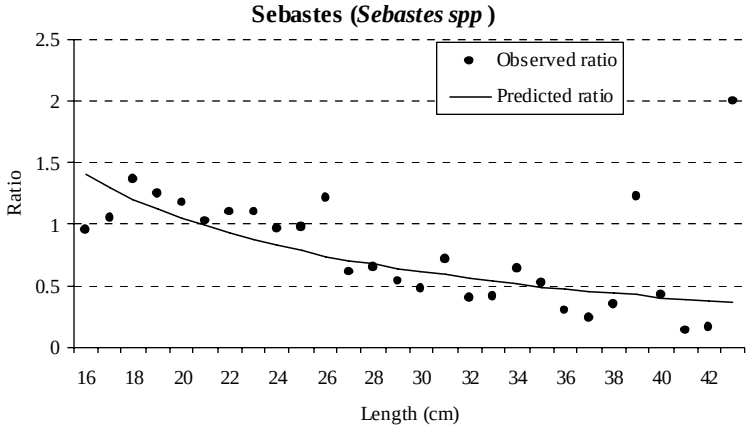
To convert the biomass, we adjust the method (1). The result of this adjust gave us a value of FPC=1.1213, that indicates that the new vessel, B/O *Vizconde de Eza*, is more or less 12% more efficient than the old vessel, B/O *Cornide de Saavedra*.

The result of the model (2) for *Sebastes* was the following:

$$\text{Ln(Ratio)} = \exp(3.5416\text{-}0.0097\ln(l)\text{-}1.1008l)$$

The figure shows the ratios and their fit. In this figure, in the case of data above 38 cm., we observed that the fit is very poor, so the mean of the ratios is applied for this values. So two length classes were formed as follow (cf = conversion factor):

For $l \leq 38$: cf = $\exp(3.5416\text{-}0.0097\ln(l)\text{-}1.1008l)$
For $l \geq 39$: cf = 0.7913



For the length distribution of individuals smaller than 16 cm, presented in some of the species of *Sebastes* since the beginning of the historical series, the correcting factor applied was the obtained from the adjust for these lengths of the *Sebastes juveniles*.

In the figure, we can see that the R/V *Vizconde de Eza* is more efficient for the smallest individuals and less efficient for the biggest individuals.

Juvenile Redfish (*Sebastes juveniles*)

Since 1990, the redfish smaller than 16 cm was classified as a different species. This group of *Sebastes* was treated as a separated species from the general analysis of *Sebastes* presented below, mostly because the adjust was better when the analysis was made separately, mainly due to that the presence of *Sebastes juveniles* in the catches of the hauls was very different than the one of the *Sebastes* bigger than 16 cm.

The juvenile redfish was present in 101 valid paired hauls, but it was present only in 93 of them in the two vessels. Of these, 8 were taken as outliers.

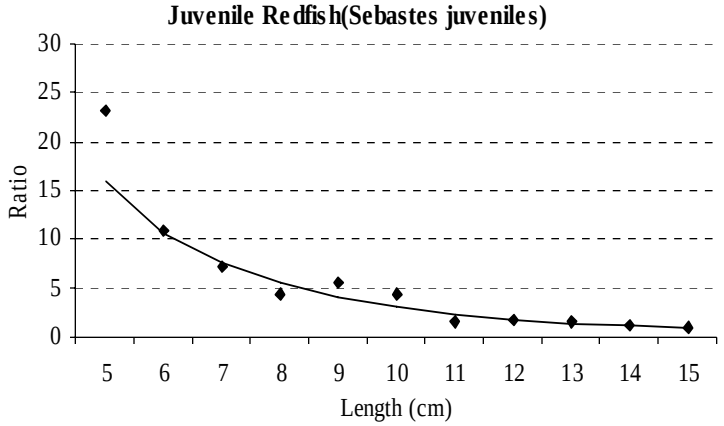
To convert the biomass, we adjust the method (1). The result of this adjust gave us a value of FPC=1.4455, that indicates that the new vessel, B/O *Vizconde de Eza,* is more or less 45% more efficient than the old vessel, B/O *Cornide de Saavedra*.

The result of the model (2) for *Sebastes juveniles* was the following:

$$\text{Ln(Ratio)} = \exp(5.7601-0.1286\ln(l)-1.4613l)$$

The figure shows the ratios and their fit. In this figure, in the case of data below 6 cm., occasionally presented in the series, we observed that the fit is very poor, so the mean of the ratios is applied for this values. So two length classes were formed as follow (cf = conversion factor):

For $l \leq 5$: cf = 16.3410
For $l \geq 6$: cf = $\exp(5.7601-0.1286\ln(l)-1.4613l)$



The R/V *Vizconde de Eza* is clearly more efficient catching the juveniles of redfish.

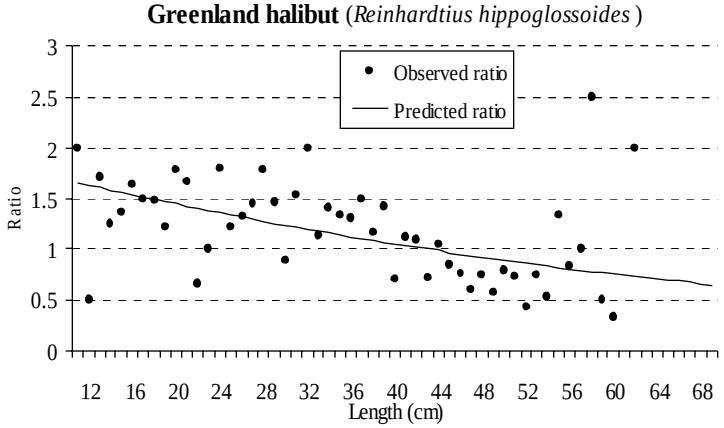
Greenland halibut (*Reinhardtius hippoglossoides*)

The Greenland halibut was present in 95 valid paired hauls, but it was present only in 83 of them in the two vessels. Of these, 3 were taken as outliers.

To convert the biomass, we adjust the method (1). The result of this adjust gave us a value of FPC=1.0159, that indicates that the new vessel, B/O *Vizconde de Eza,* is more or less only 1.5% more efficient than the old vessel, B/O *Cornide de Saavedra*.

The result of the model (2) for Greenland halibut was the following:

$$\text{Ln(Ratio)} = \exp(0.6121-0.0172\ln(l)+0.0384l)$$



In the figure we can see that the new vessel is more efficient for the smallest individuals, and less efficient for the biggest individuals.

Roughhead grenadier (*Macrourus berglax*)

The Roughhead grenadier was present in 27 valid paired hauls, but it was present only in 23 of them in the two vessels. Of these, 5 were taken as outliers.

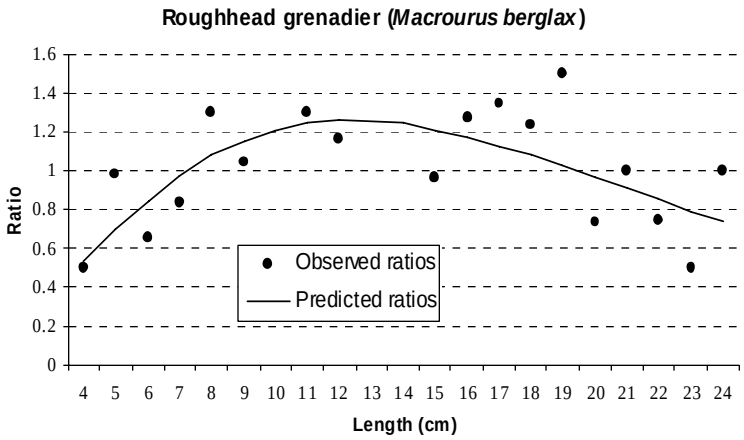
To convert the biomass, we adjust the method (1). The result of this adjust gave us a value of FPC=0.8405, that indicates that the old vessel, B/O *Cornide de Saavedra*, is more or less 16% more efficient than the new vessel, B/O *Vizconde de Eza*.

The result of the model (2) for Roughhead grenadier was the following:

$$\text{Ln(Ratio)} = \exp(-2.6671-0.1556\ln(l)+1.918\,l)$$

The figure shows the ratios and their fit. Due to the low number of individuals bigger than 19 cm., the mean of the ratios is applied for this values. So two length classes were formed as follow (cf = conversion factor):

For $l \leq 18$: $\text{cf} = \exp(-2.6671-0.1556\ln(l)+1.918\,l)$
For $l \geq 19$: $\text{cf} = 0.9139$



Northern shrimp (*Pandalus borealis*)

The results for this species are presented in another SCR (Casas *et al.*, 2004)

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