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Inter-calibration of
Participating Vessels in the
ICES Coordinated Surveys
of North Sea Herring

INTER-CALIBRATION OF PARTICIPATING VESSELS IN THE ICES COORDINATED SURVEYS OF NORTH SEA HERRING

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SUMMARY

Three pairwise acoustic inter-calibrations of the performance of EK500 scientific echosounders were carried out in July 1997. The first inter-calibration was carried out at about 57 40'N by 0E by *GO Sars* and *Walther Herwig III* on the morning of 1 July. Due to severe weather *Tridens* was unable to reach this location in time, and could not participate as planned. The inter-calibration was carried out throughout the entire survey day, during which no fishing took place. The second calibration carried out between *Walther Herwig III* and *Dana* after the completion of the first inter-calibration. During 2 July *Walther Herwig III* sailed eastward and contacted and *Dana*. The inter-calibration was carried out in the morning of 3 July at a position 57 45'N and 06 00'E about 30 Nm south west of the Norwegian coast. The third inter-calibration was carried out between *GO Sars* and *Scotia* on 16 July at about 60 45'N 30'W.

The results of the calibrations have been examined, analysis includes careful matching of threshold values and an examination of the impact of weather dependent losses. The relationships between sequences of points in space are shown and as an approximate maximum likelihood regression are presented giving confidence intervals for the three calibrations. The results show excellent agreement between the four vessels involved.

INTRODUCTION

It was recommended by the ICES planning group for herring surveys that the acoustic survey participants should utilise as many opportunities as possible for inter-calibration during the 1997 surveys. In order to minimise the effect of spatial and temporal variability of herring abundance, the method chosen was to be inter-ship calibrations, with the vessels running the same course at the same time. Since such an arrangement required some extra vessel time, which inevitably reduced the coverage of the sampling area to some extent it was important to plan this

efficiently. It was decided that pairwise inter-calibrations would be more efficient than trying to organise all vessels to be together at the same time, and it was judged to be acceptable to carry out up to two inter-calibrations per vessel.

MATERIALS AND METHODS

The first inter-calibration was carried out at about 57 40'N by 0E by *GO Sars* and *Walther Herwig III* on the morning of 1 July. Due to severe weather *Tridens* was unable to reach this location in time, and could not participate as planned. The inter-calibration was carried out throughout the entire survey day, during which no fishing took place.

The second calibration carried out between *Walther Herwig III* and *Dana* after the completion of the first inter-calibration. During 2 July *Walther Herwig III* sailed eastward and contacted and *Dana*. The inter-calibration was carried out in the morning of 3 July at a position 57 45'N and 06 00'E about 30 Nm south west of the Norwegian coast.

The third inter-calibration was carried out between *GO Sars* and *Scotia* on 16 July at about 60 45'N 30'W. There was no need for a fourth inter-calibration because *Scotia* carried out both Scottish surveys using the same equipment for both cruises.

Data Collection and Analysis Procedures for the Inter-calibration

The vessels were positioned with one in front and the other at 0.5 Nm behind on the stern quarter. The speed during the Inter-calibration was 10 knots. The period of integration depended on the extent of the fish aggregations and the time available for the survey.

The vessels took their relative positions and started sailing at the agreed speed and course. When the vessels where in a stable formation the, the leading vessel gave a start signal and started logging. The other vessel started logging after steaming 0.5 Nm. A synchronising signal was given by the leading vessel every 5 Nm at which time both vessels record their geographic position and annotated their echograms accordingly. The leading vessel was changed approximately half way through each inter-calibration ensuring that should any bias be due to a lead vessel data for examining this was available form the procedure.

A sampling interval of 1 Nm was used for integration. The integration was started at 10 m below water surface and the Sa-values were stored by 20 metre depth layers area so that eight surface channels could be registered on one echogram and provide one bottom following layer and one total layer. Threshold for the echogram was set to -80 dB for both calibrations involving *GO Sars*. The threshold was set to -70 dB for *Walther Herwig III* and the minimum level possible for *Dana* during their inter-calibration. Other than these requirements the normal survey settings were used for all other parameters.

Three pairwise inter-calibrations were carried out, a summary of the data collected are given in the text table below.

Vessels	Date and time	Distance	Comparison	Cruise track
GO Sars *Walther Herwig*	01 07 97 0900-2000 utc	90 Nm	Whole water column	Figure1
Dana *Walther Herwig*	03 07 97 0815-1300 utc	31 Nm	Whole water column	Figure 2
GO Sars *Scotia*	16 07 97 0900-1500 utc	45 Nm	Whole water column	Figure 3

Description of Individual Intercalibrations

GO Sars/Walther Herwig

The area chosen was about 40 Nm east of Fraserbrough: a short south east transect was followed by two transects south west and then north east, the particular direction was chosen specifically to minimise the effects of the weather. The inter-calibration was carried out mostly on a few scattered schools close to the seabed, these were particularly dense during the section of the track in the south west of the area. In addition, there was a consistent plankton trace in the upper part of the water column. During this inter-calibration the weather was very poor, and *GO Sars* with a keel appeared to be largely unaffected by the aeration. However, *Walther Herwig III* showed evidence of missing transmissions which are correctly excluded from the data processing by the EK system, but some signal loss was likely due to partial signal loss in bad weather which might have affected the information in the echosounder records.

Walther Herwig III/Dana

The area chosen was about 30 Nm south west from Lista on the Norwegian coast. *Dana* was in front for the first part of the track, travelling NNE. *Walther Herwig III* led during the second half travelling first west and then southwest. The water depth was between 125-150 m. The fish concentrations were made up mostly of small schools on the seabed and a midwater plankton layer. The weather was good with no sign of any signal loss due to aeration.

GO Sars/Scotia

The inter-calibration was carried out with a layer of small herring schools mixed with a very small proportion of gadoids close to the seabed. The herring contributed about 70% of the biomass, and a plankton layer near the sea surface provided the remainder of the integral. Four zig-zag transects were carried out to the north east of Shetland, *GO Sars* led for the first two transects and *Scotia* for the second two. The distributions were quite even, and most of the variation between the two vessels was due to the differences in density of schools detected by the two vessels which followed tracks at about 200 m apart from each other.

Data Processing

For the *GO Sars*, *Scotia* and *Walther Herwig III* inter-calibrations there was no difference in the equipment and settings, the results could be compared directly. In the case of *Dana* and *Walther Herwig III* the equipment was different and there is some doubt about the exact alignment of the equivalent threshold levels between these echosounder systems. It is thought that *Dana* has a threshold of -65 dB rel 1 volt, and the *Walther Herwig III* data was reworked in the BI 500 at this threshold. At the original level of -70 dB a small but significant intercept was observed in this inter-calibration, however, this disappeared when the data was reworked with the increased threshold for *Walther Herwig III.* For each intercalibration the sequence of data values were plotted as two time series and the alignment of the sequences checked for alignment and bias changing with lead (Figs 4-6). Output data values at the exchange of leadership were removed. The sequences were plotted as XY scatter plots and two linear regressions used to define a relationship between vessels (Figs 7-9). To obtain a regression relationship each data set was regressed on the other using a simple least squares regression, the final regression was selected as the mean of these two lines (solid line). The CV for this factor was calculated as the sum of the intervals for the two regressions, summed using the route mean square. The interval for the intercept was estimated in the same way. In addition the factor assuming zero intercept was calculated from the data series means.

RESULTS

The inter-calibration data details are shown in following figures.

Vessels	Sequence plot	Scatter plot
GO Sars/Walther Herwig	Figure 4	Figure 7
Dana/Walther Herwig	Figure 5	Figure 8
GO Sars/Scotia	Figure 6	Figure 9

The results of the inter-calibration are given in summary the following text table.

Vessels	Ratio	CV	Intercept	Approx limits
GO Sars/Walther Herwig	0.76	0.04	-13.4	±50
Dana/Walther Herwig	0.88	0.12	0.6	±200
GO Sars/Scotia	0.98	0.04	0.8	±360

DISCUSSION

In all cases the differences between the slope from the regression and the slope estimated with zero intercept were negligibly different. In two cases they were effectively identical. *GO Sars* and *Scotia* were found to have the same performance. The ratio from the calibration from *Dana* and *Walther Herwig III* was not significantly different from unity but did indicate the possibility of a slightly lower sensitivity for *Walther Herwig III.* The calibration between *GO Sars* and *Walther Herwig III* gave a ratio factor of 0.76, however, the accuracy of this factor and how it should be applied is currently uncertain. During this inter-calibration the weather was poor and there was some evidence of loss of signal from *Walther Herwig*, not seen on *GO Sars* which has a keel system for the transducer. The weather was the worst encountered during the whole survey, thus the effect was at its greatest. These data requires further investigation to establish if the apparent reduction from *Walther Herwig III* is weather dependent.

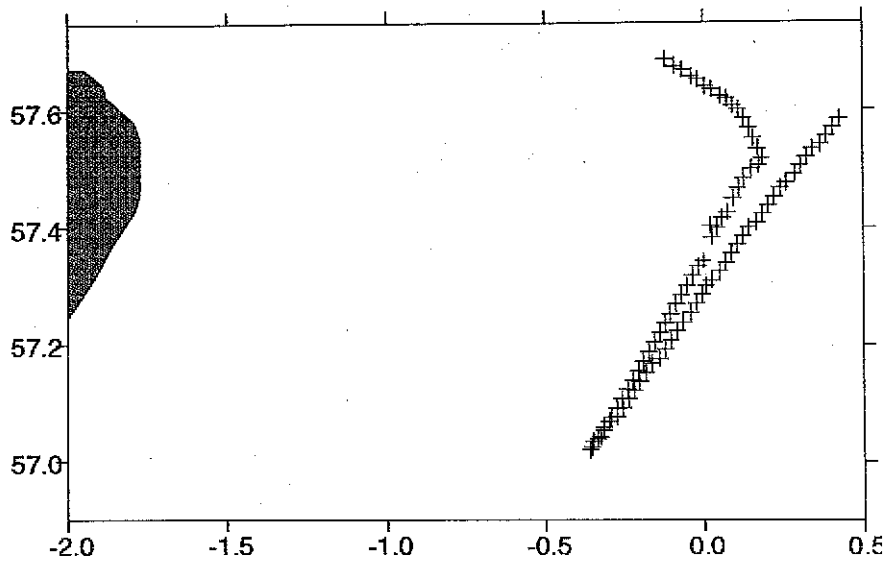


Figure 1 Inter-calibration Cruise Track *G.O. Sars* and *Walther Herwig III* 1 July 1997

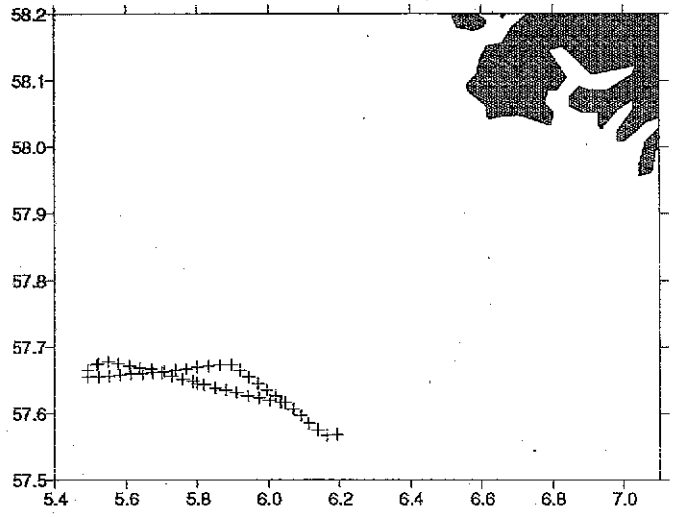


Figure 2 Cruise track for *Dana* - *Walther Herwig III* Inter-calibration 3 July 1997

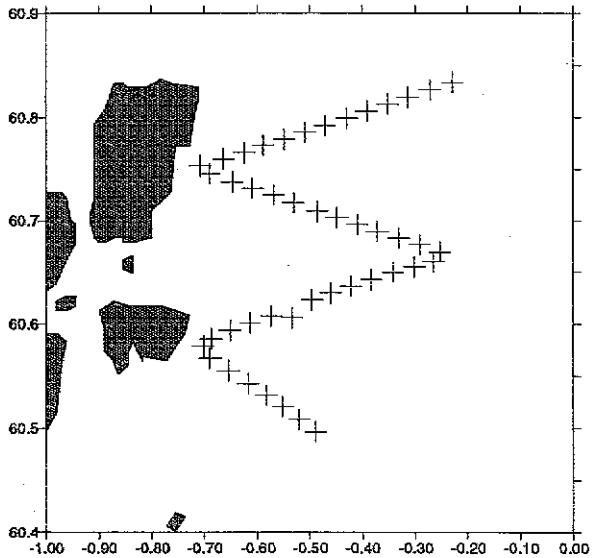


Figure 3 Cruise track for inter-calibration of *G.O. Sars* and *Scotia* July 1997

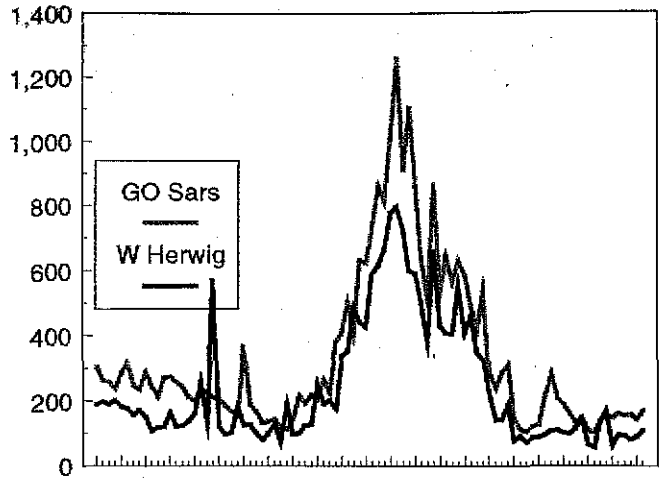


Figure 4 Sequence of echo integrator values (SA) for the whole water column for *G.O. Sars* and Walther *Herwig III* July 1997

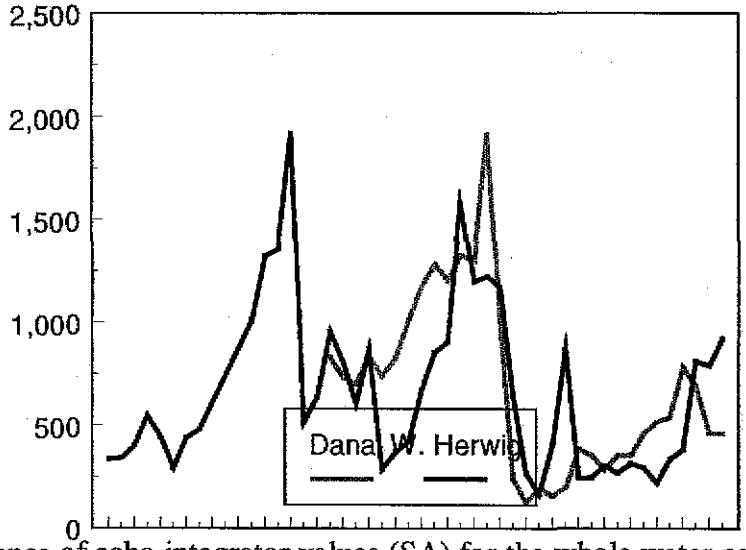


Figure 5 Sequence of echo integrator values (SA) for the whole water column for *Dana* and *Walther Herwig III* 3 July 1997

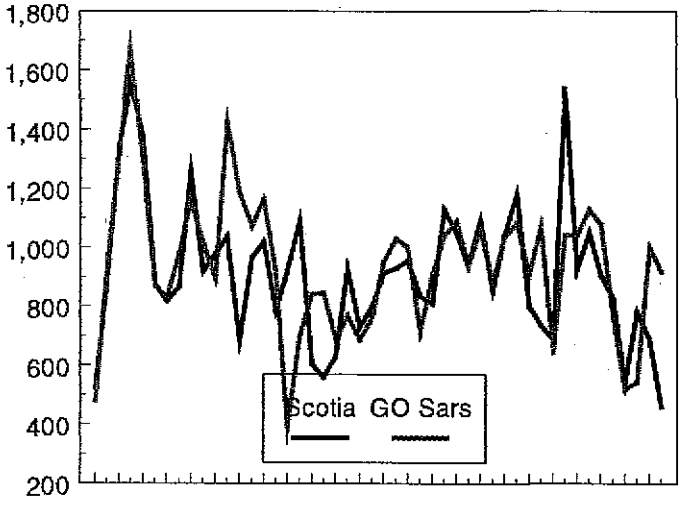
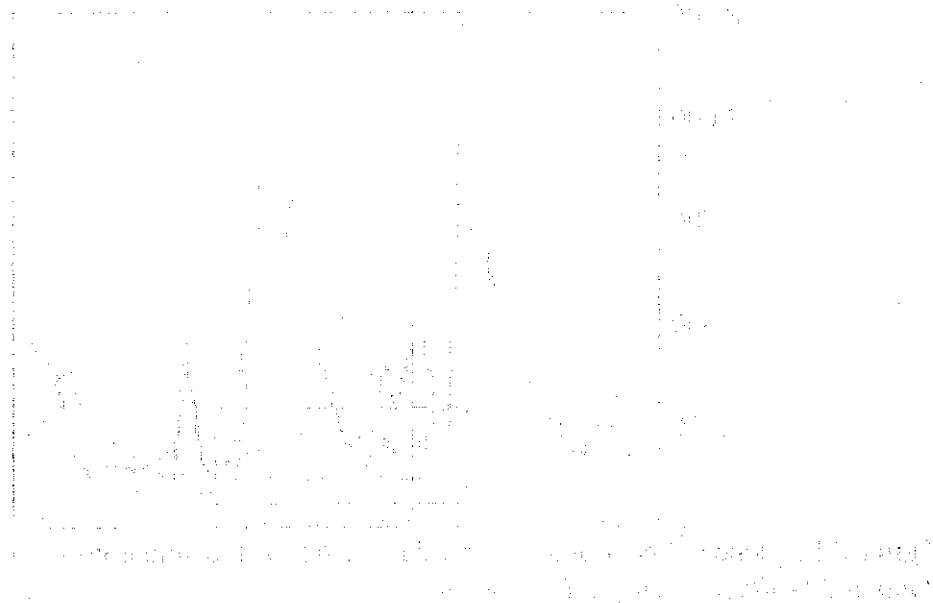
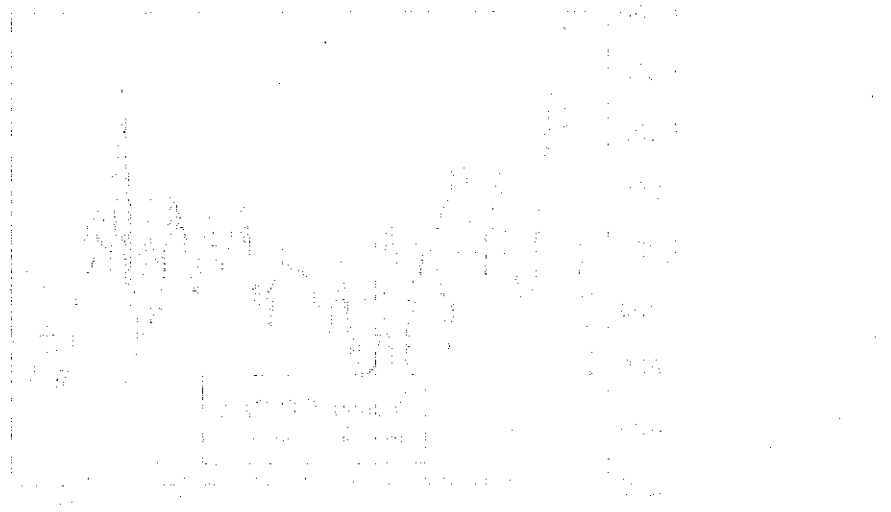


Figure 6 Sequence of echo integrator values (SA) for the whole water column for *G.O. Sars* and *Scotia* 16 July 1997





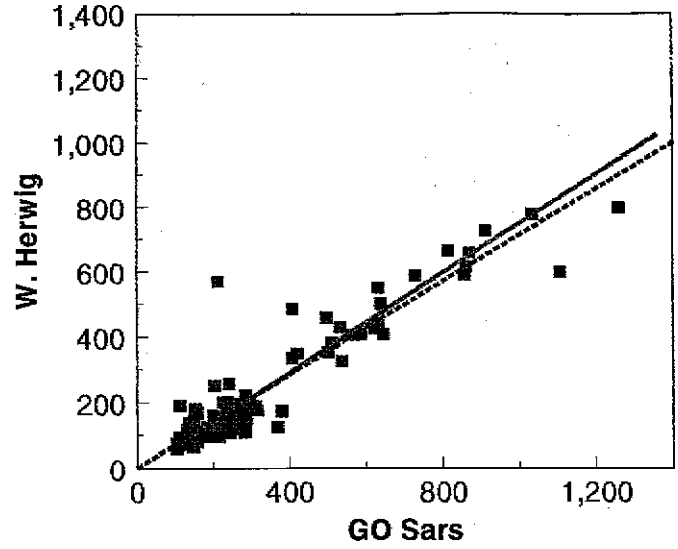


Figure 7 Scatter plot of SA values *G.O. Sars* W *Herwig III* July 1997

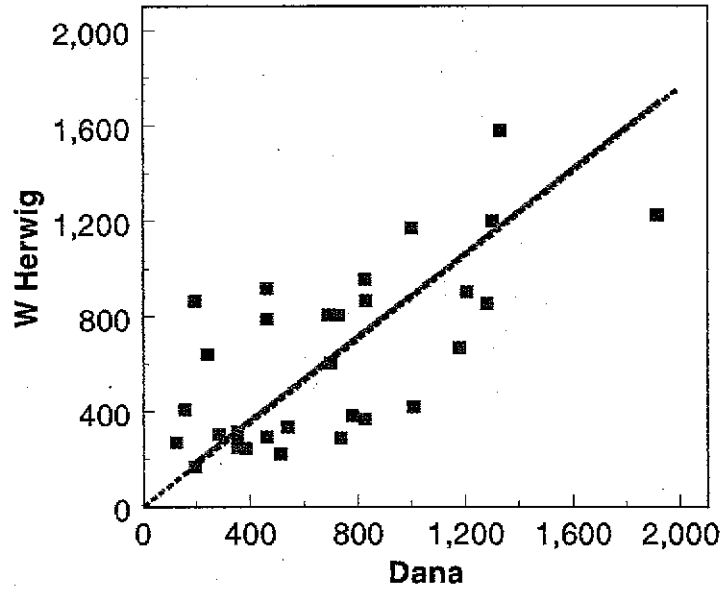


Figure 8 Scatter plot of SA values W *Herwig III and Dana 3* July 1997

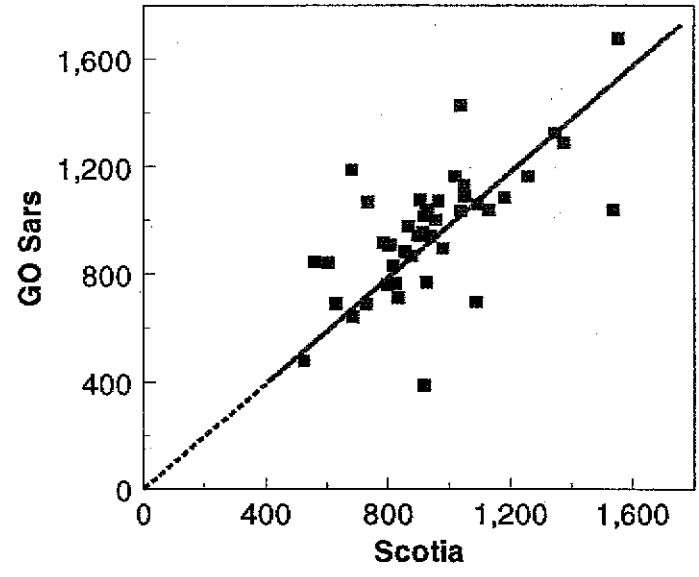


Figure 9 Scatter plot of SA values *G.O. Sars Scotia* July 1997