

Presentation given at ICES WG BIFS
2006

IMPROVEMENT OF THE BIAS SURVEY DATA UTILIZATION IN RELATION TO OVERLAPPING AREAS

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Wirt support of BSRP LL on ICES Joint Open Sea Surveys



BACKGROUND

Using data in BIAS overlapping rectangles traditionally does not go beyond pooling of abundance/biomass values by age group obtained by each vessel.

The pooling is not based on statistical parameters of samples in overlapping rectangle.

Is it possible to increase efficiency of utilization of the information obtained in the overlapping rectangles?

In this study two aspects of efficiency of using overlapping rectangle data is considered:

● **modification of procedures for pooling acoustic survey data obtained by different vessels in overlapped rectangles taking into consideration the statistical characteristics of acoustic and biological data ,**

● **expediency of utilization of overlapping rectangle data for intercalibration of the vessels.**

Material

BIAS overlapping rectangle system involves two types of rectangles covered by two vessels:

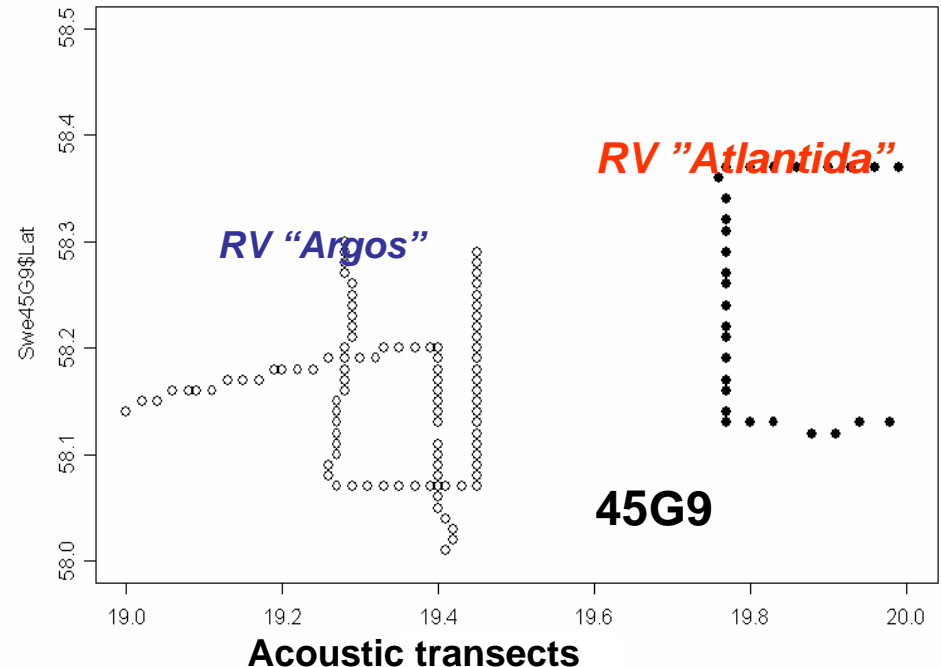
- each vessel covers the whole rectangle
- one or two vessels cover a part of the rectangle.

The first type of rectangles is of interest as it allows obtaining a larger information for comparative analysis.

In this study were used data from acoustic surveys (October 2004):

Overlapping rectangles: 44G9 и 45G9 related to whole Rect” (WGBIFS, 2005; Table 2.1.1.1

Vessels: RV “Atlantida” (Russia) and RV “Argos” (Sweden)



The Swedish and Russian vessels made 2 hauls each in the rectangular with the use of midwater trawls as follows:

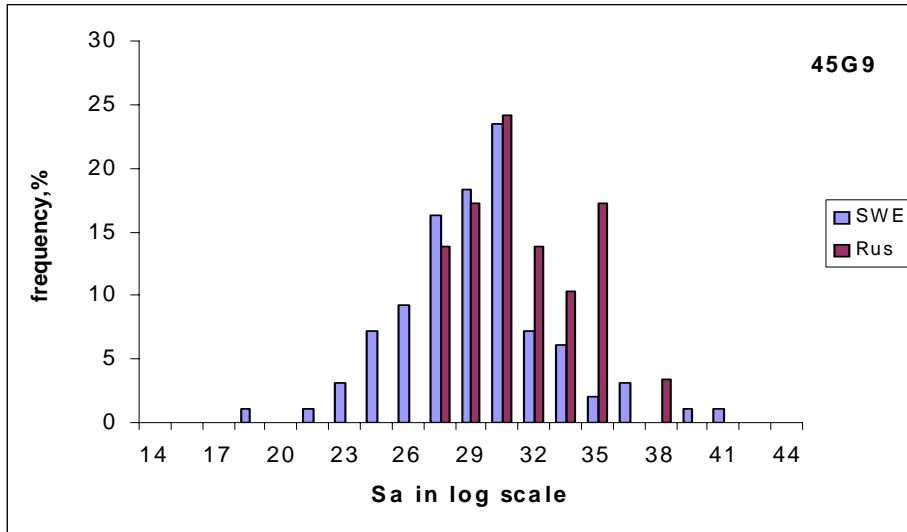
Trawl RT/TM 70/300 (RV Atlantida): vertical mouth opening 34m, mesh size in trawl codend **6.5mm, trawling speed 3.9 - 4.1 k, trawling duration 30 min.**

Trawl Macro 4 (RV Argos): vertical mouth opening within the range of 24-30m, mesh size in trawl codend **22mm , trawling duration 30 min.**

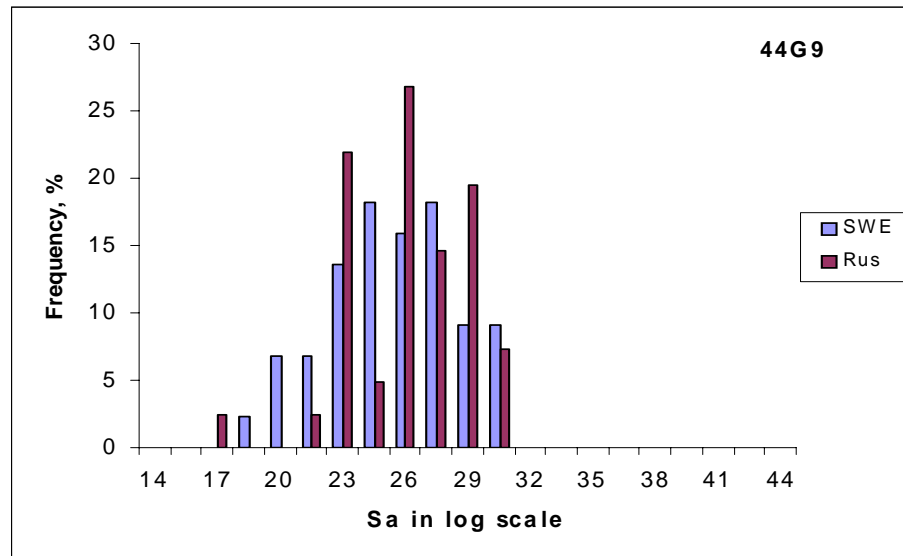
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RESULTS

Comparative analysis of the acoustic data obtained by two vessels in overlapping rectangles



Vessel-to-vessel differences between frequency distributions of Sa in each rectangle are statistically significant (Kolmogorov - Smirnov test, $P < 0.05$)



Frequency distributions are indicative of spatial heterogeneity of the fish biomass distribution within each rectangle.

Frequency distribution of Sa values

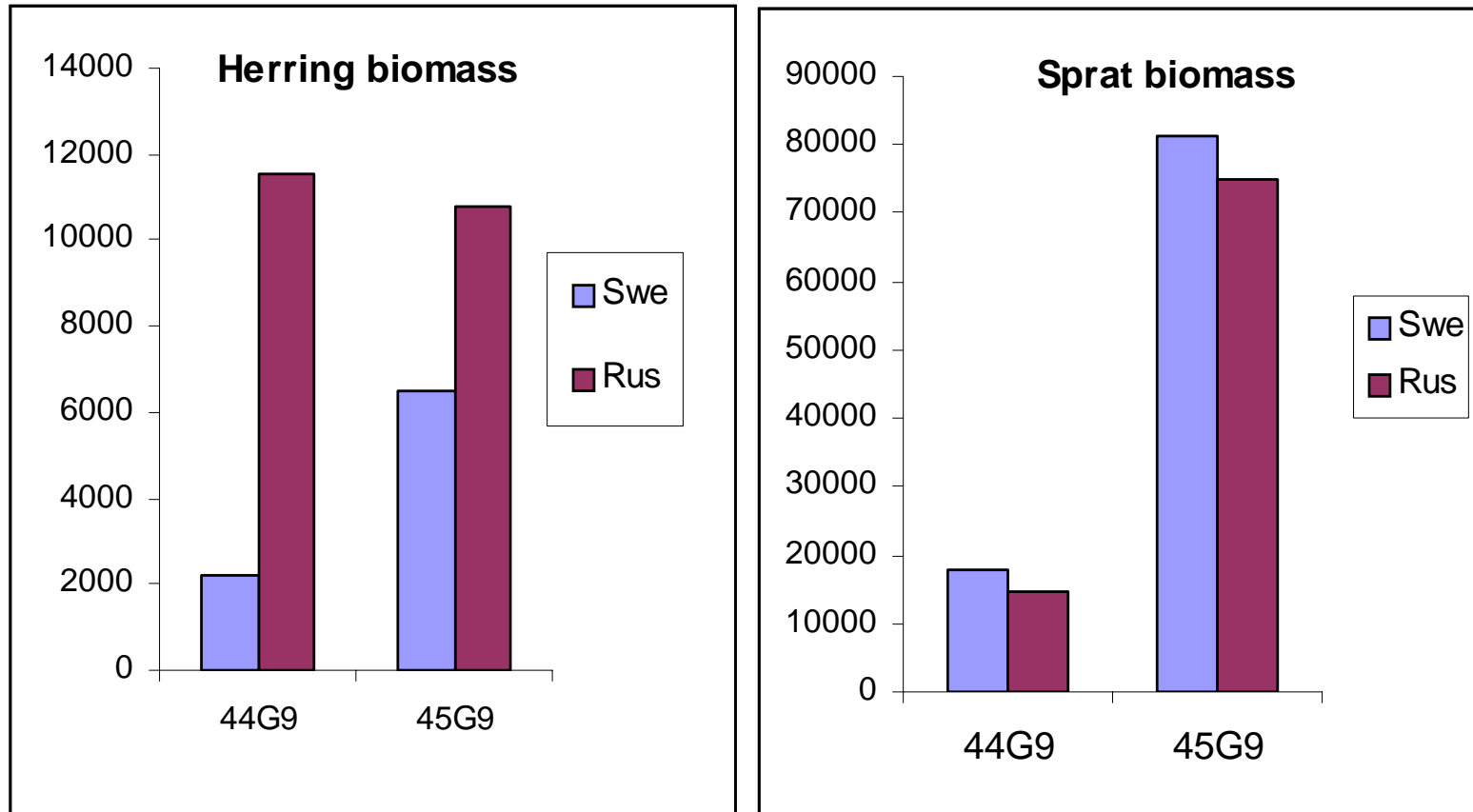
Statistics of Sa values

Rect.	<i>RV Argos</i>		<i>RV Atlantida</i>	
	44G9	45G9	44G9	45G9
mean	367.0	1050.5	410.6	1448.7
st.error	36.4	144.4	36.2	201.0
std	241.4	1421.6	231.6	1082.9
CV ,%	65.8	135.3	56.4	74.8
min	55.1	70.8	49.6	419.5
max	998.0	10048.4	1004.0	5229.0
records	44	97	41	29

Vessel-to-vessel difference between mean values of Sa amount to 12% and 37% in rectangles 44G9 and 45G9, respectively, and are statistically significant ($P < 0.05$).

High variation coefficients of Sa index and Vessel-to-vessel difference between Sa are indicative of considerable spatial heterogeneity of the fish biomass distribution within each rectangle.

Estimates of sprat and herring biomass in the overlapped rectangles



Vessel-to-vessel estimates of herring biomass in two rectangles differ 2.6 times while those of sprat biomass - 1.1 times.

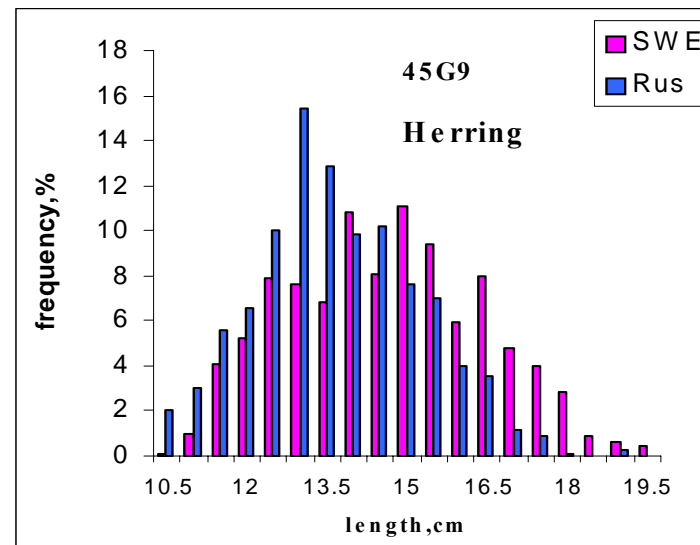
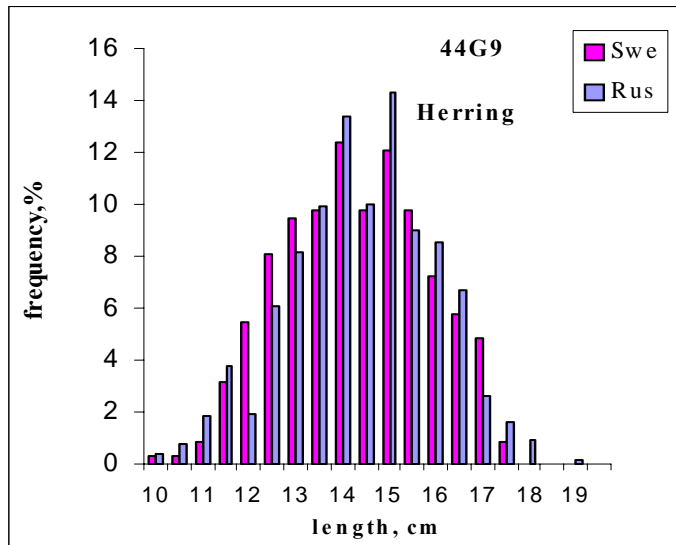
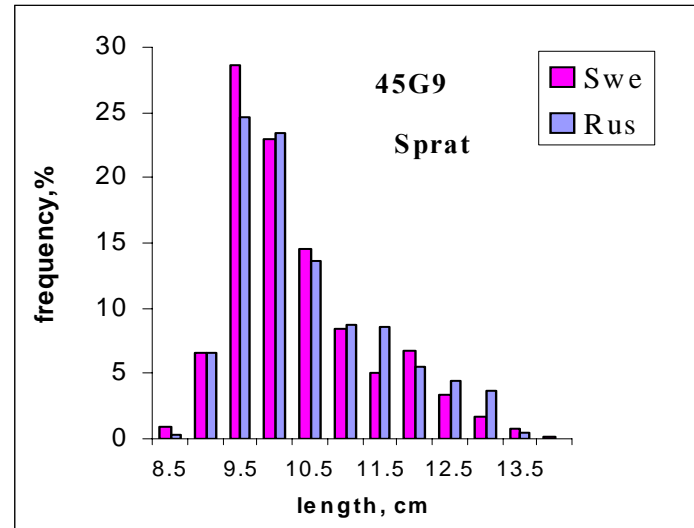
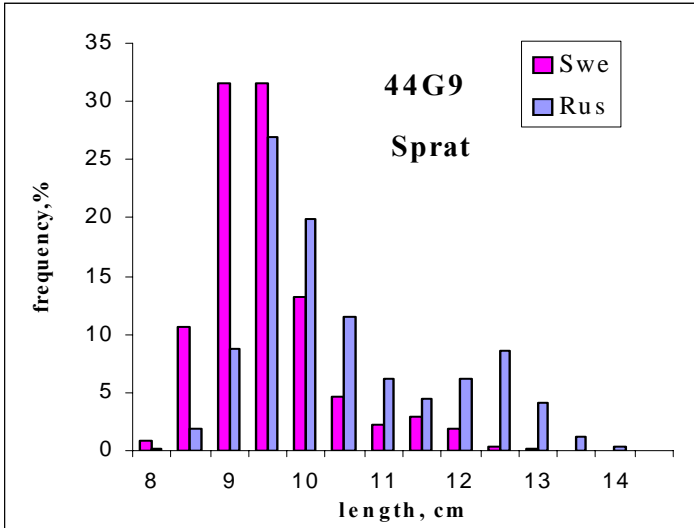
The latter proves that the aggregations of these fish species differ in spatial distribution patterns. It is obvious that herring distribution is notable for large patchiness, which makes quantitative assessment of this fish species more vulnerable to acoustic sampling design.

It is revealed that uncertainty in herring biomass estimates from BIAS results, caused by the acoustic sampling design may turn out to be grave, especially against a background of moderate stock of this fish species in the Baltic Sea and differing acoustic sampling design used by BIAS member vessels.

The analysis of influence of the acoustic transect design and of Sa sampling intensity on the results of acoustic survey is an important factor for increasing reliability of BIAS results. Apparently, overlapped areas can be used as the grounds for the research aimed at improvement of BIAS acoustic sampling strategy.

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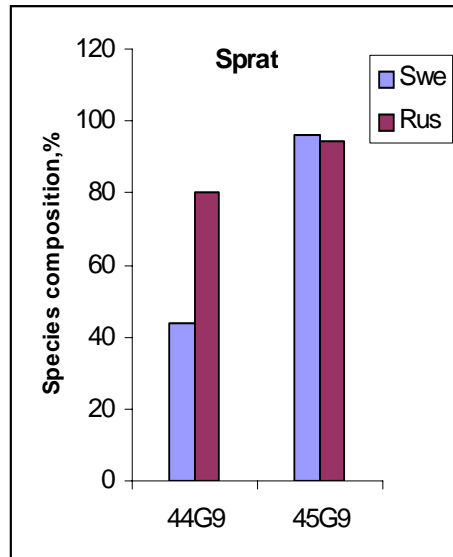
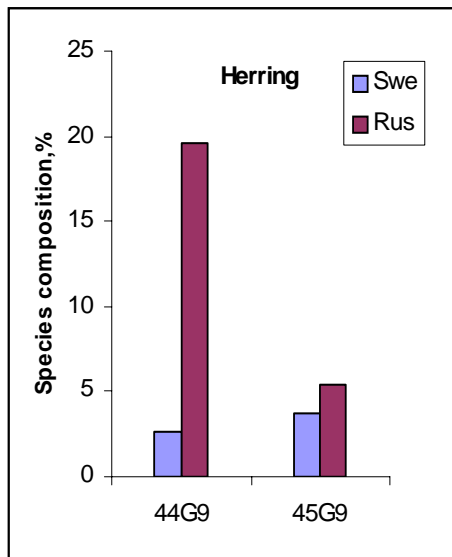
Comparative analysis of trawl samples



Differences between fish length compositions in the catches taken by the two trawls

Vessel-to-vessel differences of species and length compositions in catches

ICES Rect.	No trawl	Herring			Sprat			Other
		L, cm	w, g	Numb.,%	L, cm	w, g	Numb.,%	
<i>RV Argos</i>								
44G9	619, 620	14.28	16.62	2.7	9.99	8.57	43.7	53.4
45G9	617, 618	14.09	19.76	3.7	10.31	9.64	95.9	0
<i>RV Atlantida</i>								
44G9	11,12	15.77	21.78	19.62	10.7	6.89	80.38	0
45G9	3,4	14.4	16.8	5.43	10.69	6.79	94.57	0



Species compositions in catches of two trawls

Differences in characteristics of the catches taken by two trawls may result from:

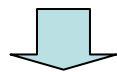
- spatial heterogeneity of the length, species and biological composition of the aggregations in the survey area;
- distinctions in differential catchability of trawls.

(codend mesh size 6.5mm and 22mm)

Traditionally, BIAS member vessels utilize different constructions of midwater trawls, leaving catchability characteristics of fishing gears out of sight.

1. Midwater trawls on BIAS member vessels are equipped with codends having different mesh sizes (WGBIFS, 2004, 2005):

Codend mesh size of **6.5 mm** for trawl RT/TM 70/300 (RV “Atlantida”);
Codend mesh size of **10mm** for trawl of the RV “Emma”
Codend mesh size of **10mm** for trawl PSN 388 (RV “Solia”);
Codend mesh size of **20mm** for trawl PSN 205(RV “W.Herwig”);
Codend stretched mesh size of **22 mm** for trawl WP 53/64X4 (RV “Baltica”);
Codend stretched mesh size of **22 mm** for trawl Macro 4 (RV “Argos”).

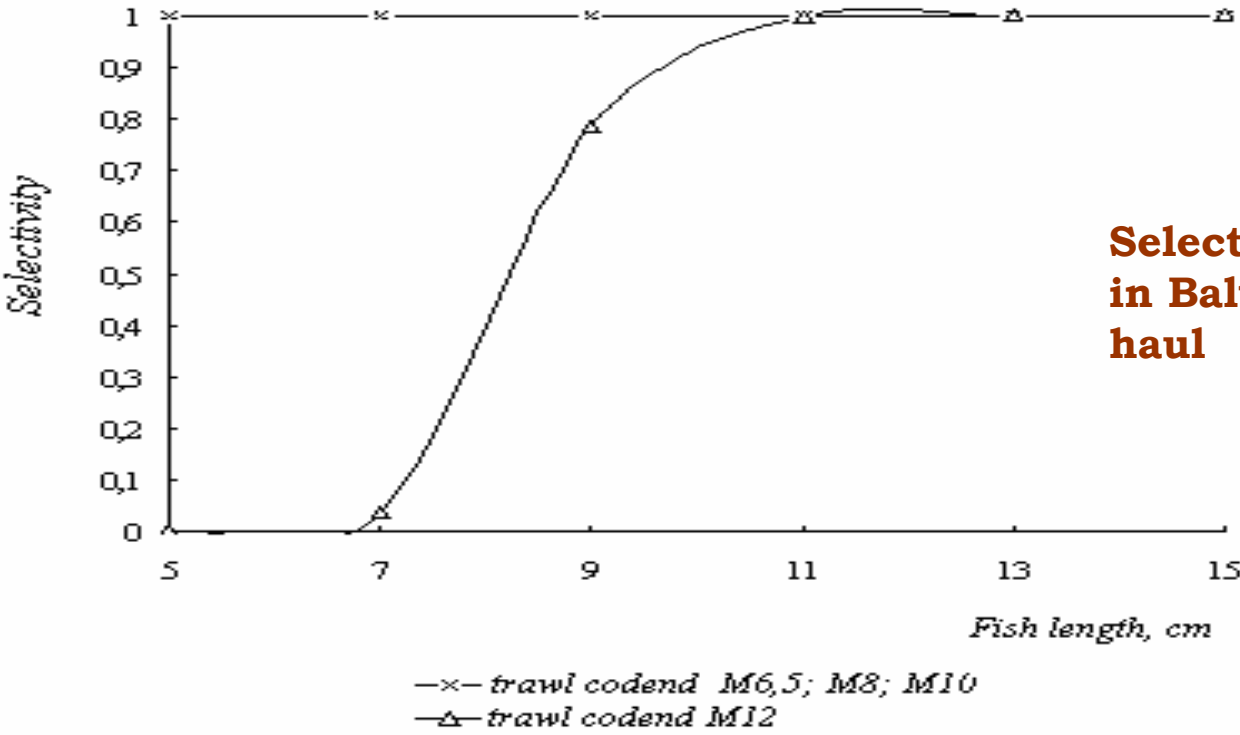


Different mesh size will be resulted in different selectivity of trawl codends



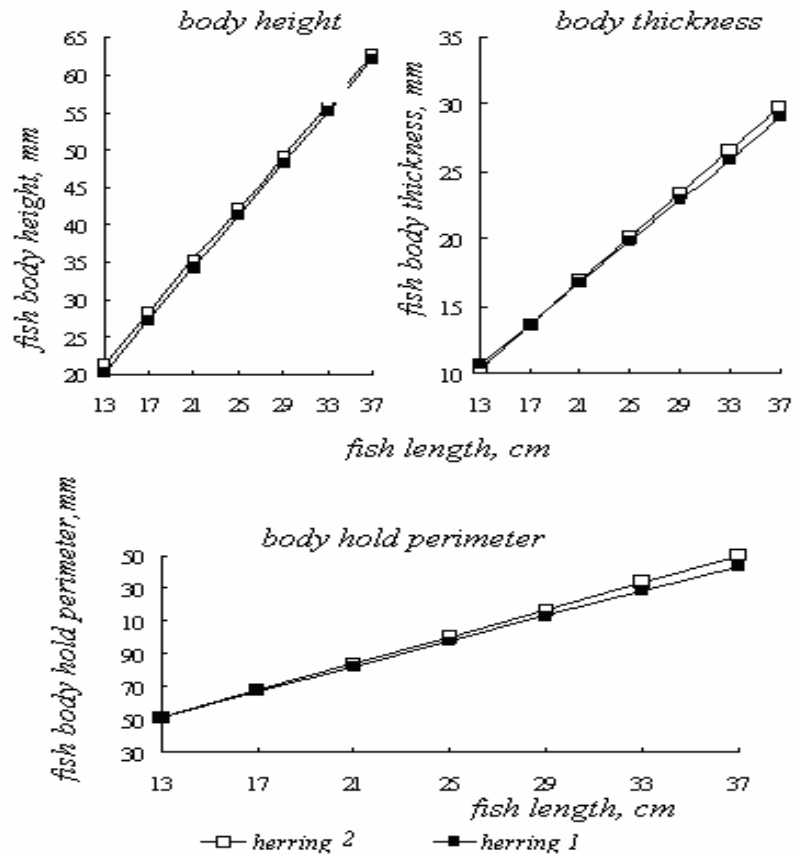
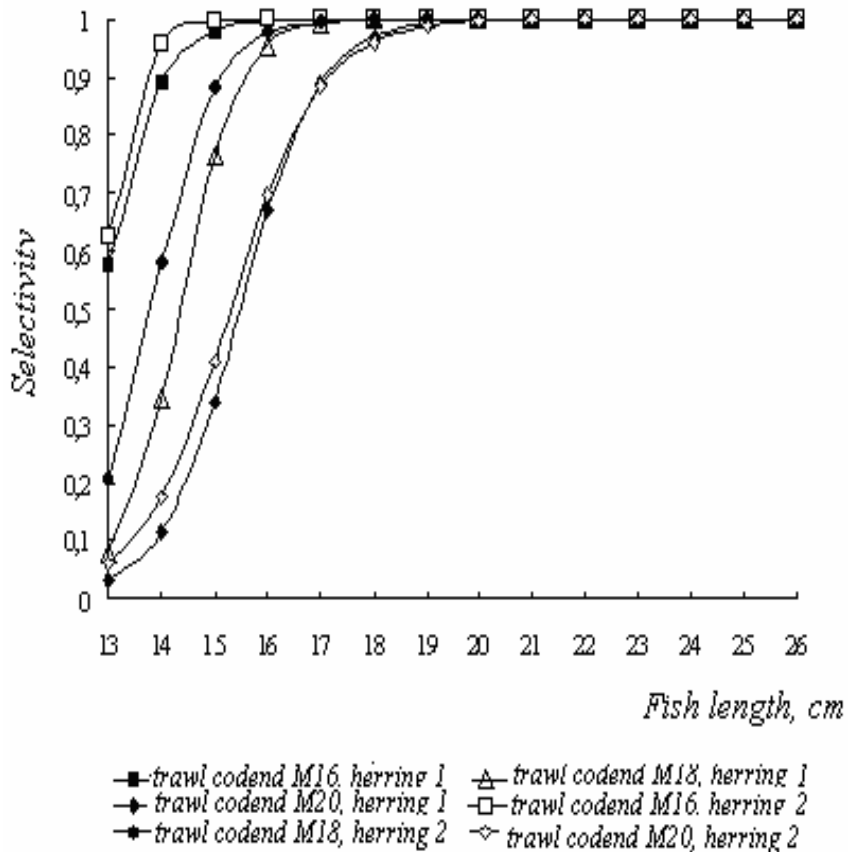
Apparently, the influence of trawl codend selectivity on fish length and species composition in catches during BIAS may be significant (Observed results from Russian and Swedish trawls are illustration of this).

Nature of influence of mesh size and biometric fish on codend selectivity under example on selectivity investigations of trawl codends used in Russian herring and sprat fishery (Ivanova et al, 2002)



All length classes of sprat and herring under 15cm in length are completely retained in the codend with mesh size to 10mm

Biometric parameters used in calculation of codend selectivity



Selectivity of trawl codends in relation to different mesh size and different biometric parameters for Baltic herring body

2. Vertical mouth opening of trawls used on BIAS member vessels varies within the range of 8-35 m (Reports of WGBFS):

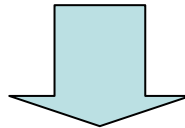
Opening of 8-10m for trawl PSN 388 (RV "Solia");
Opening of 14m for trawl PSN 205 (RV "W.Herwig")
Opening of 22m for trawl Macro 4 (RV "Argos")
Opening of 34m for trawl RT/TM70/300 (RV "Atlantida").



Distinctions between vertical trawl openings will be determined by different volume of action zones of fishing gears (i.e. different volume of water will be fished by research trawls)

Small vertical opening of trawl PSN 388 indicates that length composition of the catches taken by this trawl will rather be represented by individual fish schools, while trawl RT/TM70/300 will give averaged value of schools structure within the 35-meter fished depth layer.

3. As a whole, differences between action zones and selectivity of trawl codends will be implemented considering various differential catchability of fishing gears used in the BIFS process.



The differential catchability especially effects on differing structure of catches yielded by the vessels under condition of spatial (vertical and horizontal) heterogeneity of length and species composition of aggregations in the survey area.

Differences in differential catchability of trawls used by various vessels participating in surveys are one of the most important sources of uncertainty in estimating abundance indices by age group obtained from the BIFS results.

A possible approach to solution of the said problem :

□ intercalibration of trawls used for BIFS; the system of overlapping rectangles can be used as the ground for investigations of this kind.

□ the alternative to intercalibration is a comparative analysis of catchability characteristics of trawls with the use of analytical models of trawl fishing . The probability - statistical theory of fishing trawls developed in the AtlantNIRO (Kadilnikov, 2002) is suggested to be used as such models.

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Pooling acoustic survey data obtained by different vessels in overlapping rectangles

Spatial heterogeneity of fish distribution in overlapping area becomes apparent in variability of :

- primary data from each vessel (Sa records, length and species fish composition in catches)**
- significant vessel-to-vessel distinctions in parameters of respective samples.**

Traditionally

The pooling procedure is based on the following data compared between the vessels:

- ❖ the covered area of the rectangle,**
- ❖ the number of hauls in the rectangles**

The suggested modification:

- ❖ **estimate the acoustic and biological data variances for each vessel and**
- ❖ **incorporate the above variances into the pooling procedure of overlapping rectangles data**

The advantage of these estimates compared with simple arithmetic mean :

variances apply the integrated approach to the volumes of observations made by each vessel as well as spatial variability , if the coverage of a rectangle by each vessel differed.

The suggested modification of the pooling procedure in overlapped rectangles:

- ❖ Statistical characteristics of abundance and biomass for each vessel are estimated by simulation (Kasatkina and Gasyukov, 2004, 2005);
- ❖ Combined indices are estimated by weighing indices of each vessel to a corresponding dispersion (Cochren, 1963);
- ❖ Dispersion of combined index is estimated (Patterson K., 1995):

$$N = (1 - \theta) \cdot N_1 + \theta \cdot N_2$$

$$\theta = \frac{D_{N1}^2}{D_{N1}^2 + D_{N2}^2}$$

$$D_N^2 = (1 - \theta)^2 \cdot D_{N1}^2 + \theta^2 \cdot D_{N2}^2$$

where D_{N1}^2 and D_{N2}^2 are dispersions of respective N_1 , N_2 values of the first and second vessels.

Combined estimates calculated for Rectangle 45G9 by two method

Параметры	<i>RV Argos</i>			<i>RV Atlantida</i>		
	Total abundance	Abundance of sprat	Abundance of herring	Total abundance	Abundance of sprat	Abundance of herring
Mean	8843.3	8489.9	353.4	11954.3	11303.2	651.1
Median	8375.4	8048.5	333.9	11495.5	10857.5	616.1
Standard deviation	2677.4	2571.9	117.3	3510.8	3323.6	216.0
Koefficient of variation	0.303	0.303	0.332	0.294	0.294	0.332
Lower limit (95% CI)	4623.8	4447.5	176.5	6617.7	6246.7	335.6
Upper limit (95% CI)	15166.6	14535.6	629.2	20378.2	19205.4	1204.8

Параметры	<i>Combined indecis</i>		
	Total abundance	Abundance of sprat	Abundance of herring
Mean	9987.3	9543.6	421.1
Median	11051.9	9564.4	358.4
Standard deviation	3035.6	2149.1	108.7
Koefficient of variation	0.3040	0.2252	0.2582
Lower limit (95% CI)			
Upper limit (95% CI)			

<i>Combined indecis by traditional pooling</i>		
Total abundance	Abundance of sprat	Abundance of herring
10398.8	9016.7	502.2

CONCLUSION

The system of overlapping rectangles existing within the framework of BIFS can be used as the ground for conducting a wide scope of research aimed at improvement of the surveys. The latter will require a change of trawl and acoustic sampling strategy in these rectangles.



THANK YOU