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ESTIMATING UNCERTAINTY IN BIOMASS AND ABUNDANCE ASSESSMENTS FROM RESULTS OF THE ACOUSTIC SURVEYS

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Introduction

Fisheries management requires risk assessment and methods for quantitatively evaluating changes in fish stocks or ecosystem state. Fisheries resource surveys provide major information for assessment of abundance indices applied in tuning integrated statistical methods of fish stocks assessment (ADAPT, Gavaris, 1988), (XSA, Shepherd, 1991,1999), (ICA, Patterson, 1994).

Acoustic survey uncertainty that includes biomass and abundance statistical characteristics should be estimated and incorporated into ecosystem analysis, assessment models and management advice (WGFAST, 2005,2006; Special session of ICES ASC -2006).

Objectives

- ❑Consider the method of simulation, developed at AtlantNIRO for assessment of the total survey uncertainty.

- ❑ Demonstrate practical application of this method by the example of the Baltic acoustic survey using Russian data

According to the advanced practice of acoustic surveys uncertainty is estimated as the total sampling uncertainty, related to the spatial variability of the acoustic index Sa and length-species fish composition in the survey area (ICES WKSAD, 2004, ICES WGFAST,2004). This variability is the result of peculiar biology, behavior and distribution of fish, and the estimated survey uncertainty indicates correspondence of acoustic and trawl strategy to the spatial uncertainty of fish distribution

Taking in account the fact that the vessels participating in the Baltic international surveys fulfill trawl and acoustic sampling according to the current Manual (2002), the results obtained by us will reflect the general features of BIAS.

Simulation method for assessment of uncertainty of abundance and biomass estimates (a)

- Includes the next sources of uncertainty:
  - Spatial variability of acoustic index Sa
  - Spatial variability of species composition
  - Spatial variability of length composition of the each species within the survey area
  - Uncertainty in target strength parameters

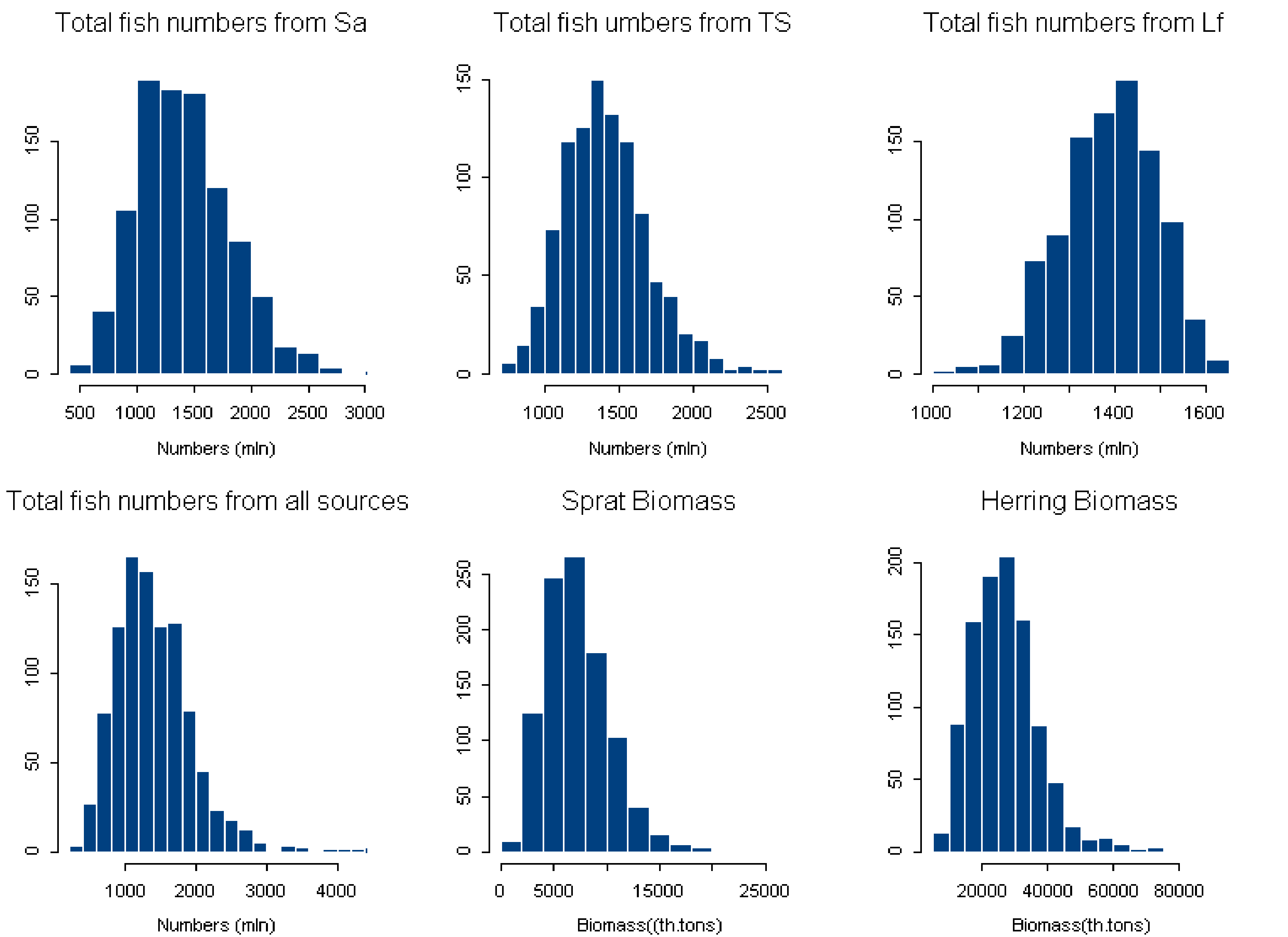
Simulation method for assessment of uncertainty of abundance and biomass estimates (b)

- Each uncertainty is simulated by the bootstrap resampling method
- Simulation of the replicates was carried out by parametric bootstrap (TS) and empirical distribution functions (Sa, length composition of the each species)
- 1000 replicates

Input data for simulation

- Regression equation of the target strength with B_{20}=-71.2 dB
- Standard error of B_{20} equals to 1.2 dB (Foot, 1986)
- Standard error of B_{20} equals to 0.5 dB was used to show dependence of the simulation results from TS
- Russian acoustic survey data in 26 SD were used (2005)

Frequency distribution of total abundance vs uncertainty sources (38G9)



Statistical characteristics of biomass and abundance in the Rect. 38G9

Parameters	Total abundance, mln sp			
	Sources of uncertainty			
	Variability of Sa distribution	Target strength	Variability of length and species compositions	All sources
Mean	1404.6	1409.4	1385.9	1393.3
Median	1366.6	1379.4	1393.1	1336.2
Standard deviation	409.7	290.3	104	527.6
Coefficient of variation	0.292	0.206	0.075	0.379
Lower limit (95% CI)	708.8	922.1	1174.3	585.4
Upper limit (95% CI)	2365.1	2060.4	1568.3	2598.9

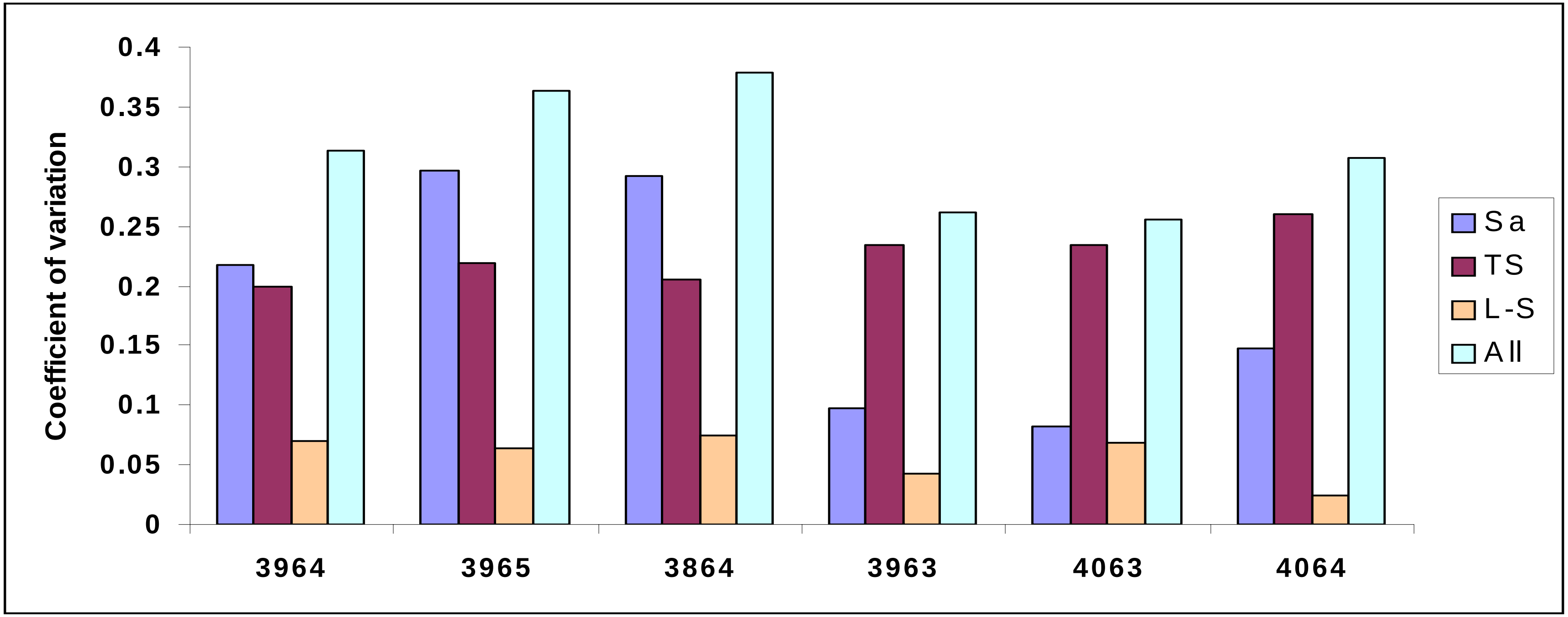
Parameters	Total biomass,t	
	Biomass of sprat	Biomass of herring
Mean	7237.2	27190.5
Median	6698.9	26398.7
Standard deviation	3094.4	10564.8
Coefficient of variation	0.428	0.389
Lower limit (95% CI)	2548	11140.8
Upper limit (95% CI)	14081.1	51682.8

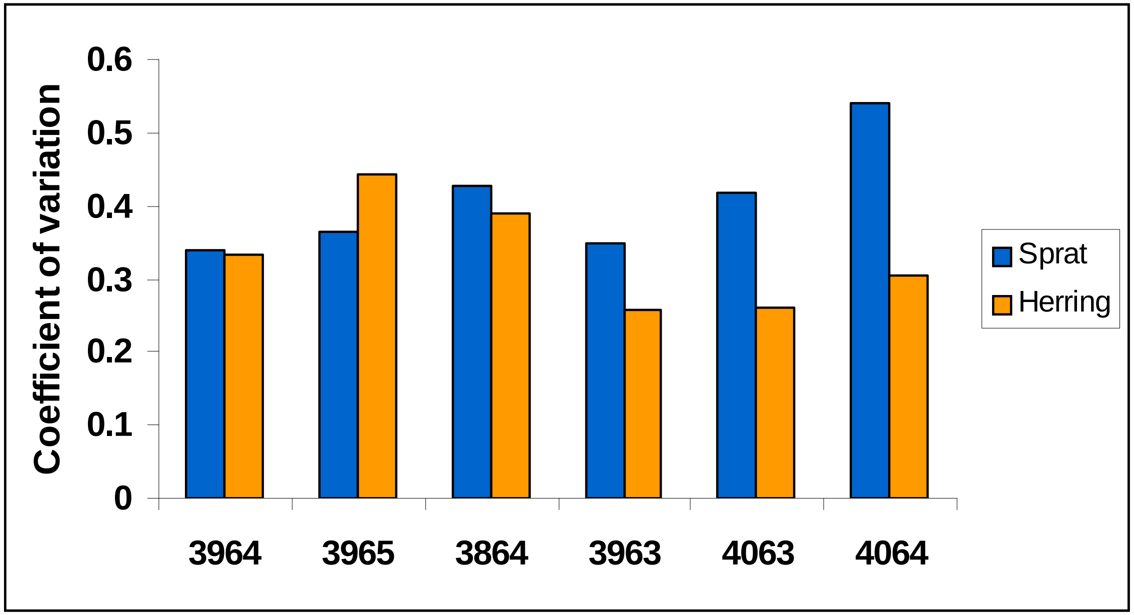
Statistical characteristics of biomass and abundance in the Rect. 39H0

Paramerers	Total abundance, mln sp			
	Sources of uncertainty			
	Variability of Sa distribution	Target strength	Variability of length and species compositions	All sources
Mean	6929	7056.2	6989.4	6924.8
Median	6822.9	6896	7001	6609.1
Standard deviation	2058.1	1544.9	445.6	2518.1
Coefficient of variation	0.297	0.219	0.064	0.364
Lower limit (95% CI)	3417.8	4293	6118.5	2811.1
Upper limit (95% CI)	11685.5	10249.3	7809.7	12961.5

Parameters	Total biomass	
	Biomass of sprat	Biomass of herring
Mean	47985	28705.9
Median	46226.7	26886.4
Standard deviation	17442.7	12751.7
Coefficient of variation	0.364	0.444
Lower limit (95% CI)	18874.8	11155.6
Upper limit (95% CI)	88709.4	61863.2

Statistical characteristics of abundance estimates

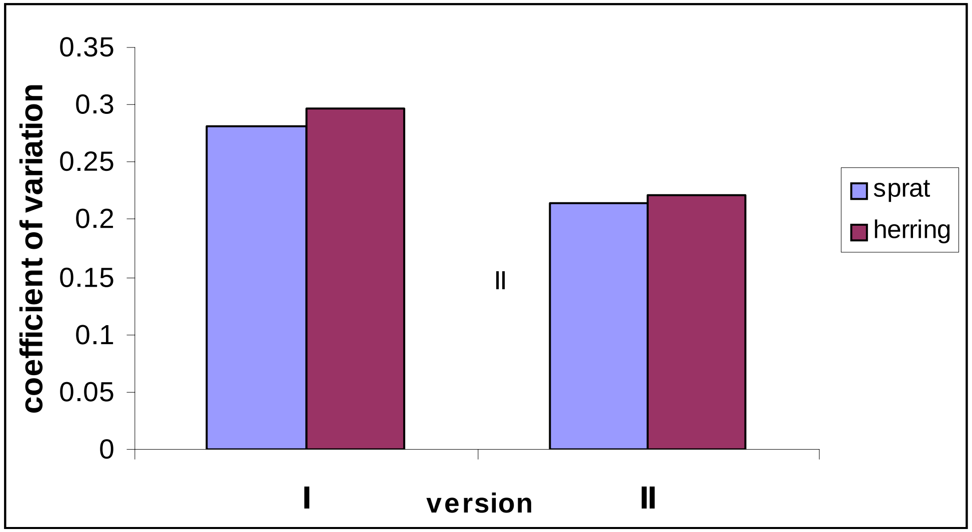




Biomass coefficient of variation

Influence of the TS uncertainty on biomass and abundance estimates

Parameters	Total Abundance	
	sd(B20)=1.2 dB	sd(B20)=0.5 dB
Mean	10786.9	10655.7
Median	10406	10506.4
Standard deviation	2871.6	2009.8
Coefficient of variation	0.266	0.189
Lower limit (95% CI)	6247	7238
Upper limit (95% CI)	17424.4	15211.9

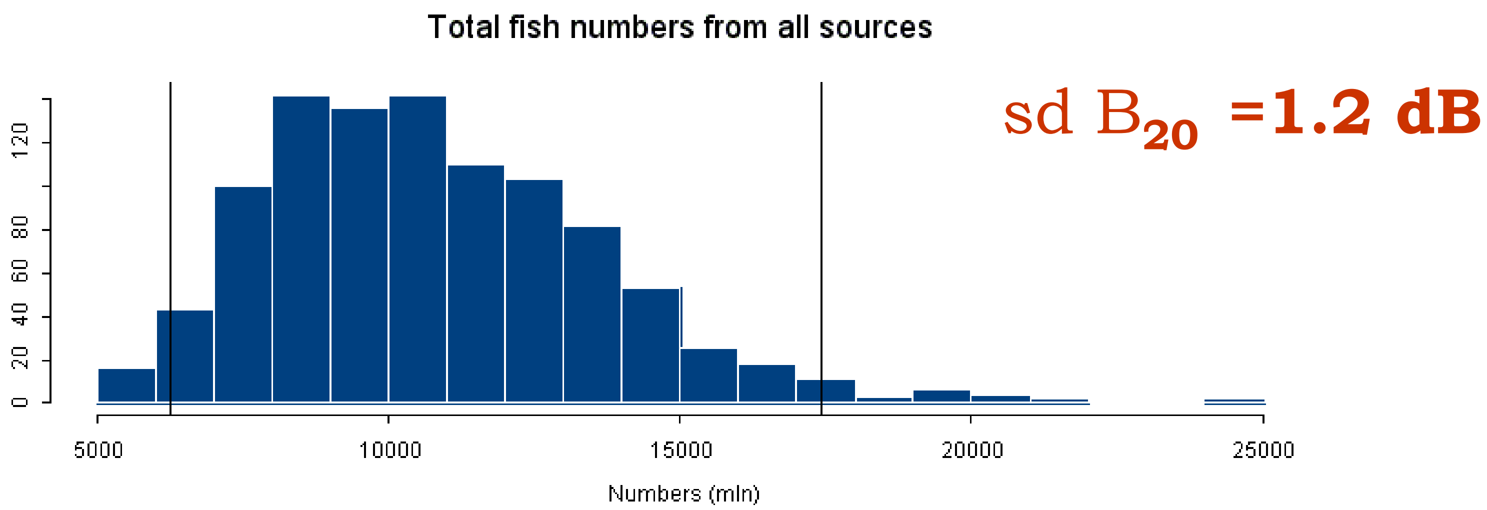


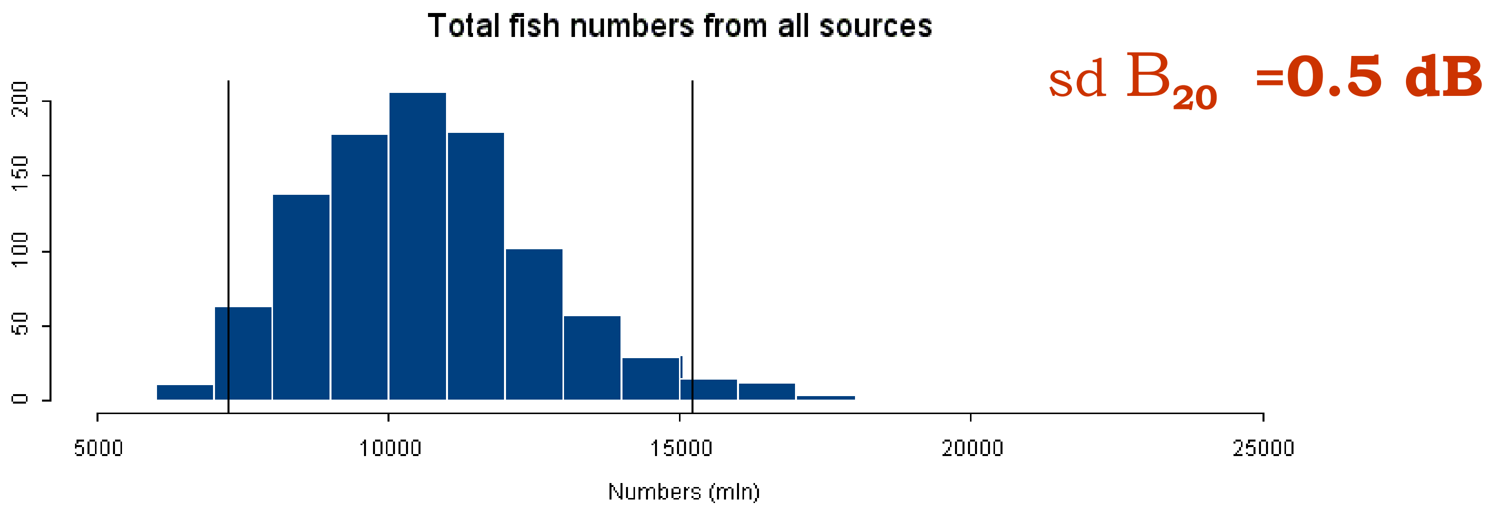
Biomass vs version of B_{20}

I - B20=1.2 dB

II - B20=0.5 dB

Frequency distribution of total fish abundance





Conclusions

- The method estimates sprat and herring abundance and biomass with CV ~0.30
- Standard errors and 95% confidence intervals are presented
- Method can be applied to whole survey area and prepare input data (sigma values of pdf) for analytical method of stock assessment in the Baltic Sea

The results show the ways to improve the accuracy of acoustic surveys in the Baltic Sea

- Increasing the number of acoustic samples in rectangles with high Sa variability (for example, 3864 and 3965)
- Updating parameters of the target strength regression
- Changing the current practice of trawl station distribution revising stratification of the survey area