

**Report of the
Study Group on Target Strength Estimation
in the Baltic Sea**

**Bergen, Norway
17–18 June 2003**

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1 EXECUTIVE SUMMARY

The Study Group continues to work by correspondence.

The 2002-report and a summary report on the work at the 2003 meeting in Bergen are made available to the 2003 ACS-meeting in Tallinn.

The group recommends a TS-relation based on fewer terms than suggested in the 2002-report and to consider some effects included then as corrections to the biomass calculations instead of the target strength.

A final report based on previous material and new data presented during the 2003-meeting will be compiled and presented within 1 year. It is recommended that this report is submitted as a Cooperative Research Report.

2 MEETING REPORT

2.1 Participation

The meeting was attended by:

Participants:

Bo Lundgren	Denmark	(Chair)
John Horne	USA	Observer
Michael Jech	USA	Observer
Thomas Axenrot	Sweden	
Tomas Didrikas	Sweden	
Egil Ona	Norway	
Natalia Gorska	Poland	Observer
Andrzej Orłowski	Poland	
Faust Shvetsov	Latvia	
Guntars Strods	Latvia	Observer
Vladimir Severin	Russia	
Adrián O. Madriolas	Argentina	Oobserver

2.2 Terms of Reference

According to the Annual Science Conference Resolution (2001/2B04) in Copenhagen, the Study Group of Target Strength Estimation in the Baltic Sea [SGTSEB] (Chairperson: Bo Lundgren, Sweden) will meet in Bergen, Norway from 17–18 June 2002 to:

- a) evaluate the single target TS measurements on herring and sprat during the surveys in 2001-2002 and from cage experiments in the Baltic;
- b) apply the modelling methods on the case of the herring and sprat and compare their results to the existing information and single target TS measurements and cage experiments in the Baltic Sea
- c) recommend TS length relationships for herring and sprat in the Baltic Sea.

SGTSEB will make its report available by 31 July 2003 for the attention of the Fisheries Technology Committee and the Baltic Committee. It will also make it available to WGFASST.

2.3 Priority

The variability and trends on the TS of Baltic herring have been recognized as important.

2.4 Scientific Justification

The reasons and sources of variations are rather well documented and understood in the particular case of the Baltic Herring population. Although these sources of variation are particularly important in the case of the Baltic herring, it is clear that they are not specific to this population and that any result on this particular population would have potential application on other stocks.

Due to the fact that (a) there is an urgent need of improving the definition of the TS of Baltic Herring (b) there is good knowledge of this population and (c) there are potentially good possibilities of measurements and experimentation on this fish, this population could be considered as a test population for the WGFASST members to understand and improve the meaning and value of target strength on pelagic fish.

2.5 Participants

Anticipate attendance of 8-10 persons. Appropriate members will attend the WGBIFS meeting in April 2003 to discuss these new ToR with Baltic acoustic colleagues and prepare the data for the Study Group meeting in 2003.

2.6 Meeting activities

This was the third meeting of the Study group and it took place in the room "SKUTEN" at the Institute of Marine Research (IMR), Fish Capture Division.

The TOR's and work of the previous meetings were reviewed.

The delayed report for 2002 was presented and finalised. Report has been submitted to ICES.

The TS-relation suggested in the 2002 report was discussed in the light of the latest literature and the practical and theoretical experience of the participants. A change of the relation was suggested.

Overview regarding a TS-size relation of herring in the northern Baltic proper based on data from Sweden and Lithuania was presented.

A new set of X-ray-photos on 51 specimen of herring and 31 specimen of sprat caught in the northern and southern parts of Subdivision 25 during the Swedish October 2002 acoustic survey was presented.

Extracts from a set of acoustical survey data obtained in connection with an intensive trawling exercise (trawling app. every 3 hours on the same track for two days) were presented.

Data were obtained on the Danish RV DANA in Subdivision 25 during March 2002

The ideas behind the KRM-modelling of the acoustic scattering of x-rayed fish and the results given in the 2002 report were presented by John Horne.

Lists of available ships and echosounders in the Baltic area as well as acoustic cruises planned were presented.

3 REVIEW OF PREVIOUS TOR'S

Appendix B contains TOR's and comments.

4 DISCUSSION REGARDING REQUIRED TERMS IN THE TS-RELATION

The 2002 Study Group report suggests the use of a generalized TS-relation including both physical and biological factors. The discussion during the 2003 meeting reviewed several of the factors influencing the possibility to get correct biomass estimates during a cruise and how to distinguish between the more inherent TS of a fish due to its physical and biological condition and its more apparent TS due to behaviour like tilting and avoidance. The conclusion was that only a few of the previously suggested terms can be backed up by sufficiently comprehensive investigations. It was decided to recommend a TS-relation with fewer terms than before:

$$TS = f(\text{length}) + f(\text{frequency}) + f(\text{pressure})$$

expressing the influence of fish length, frequency, pressure (depth) with function parameters dependent on expected tilt distribution and geographic area, the latter including for example hydrographical conditions. These parameters need to be established experimentally or by modelling for each location.

It was also decided to recommend that effects due to avoidance, school absorption, bad weather absorption and similar should rather be treated as corrections to the biomass calculations instead of corrections to the target strength.

With this modification and with background in Norwegian experiments particularly regarding the depth dependence it was expected that the TS-values could be expected to be higher than according to the presently accepted TS-relation. It was also pointed out that the latest pressure-history may influence swimbladder size and thereby TS.

5 NEW DATA ON THE TS-RELATION OF HERRING

An overview regarding new data on the TS-size relation of herring in the northern Baltic proper based on combined gillnet and acoustic surveys and some combined trawl and acoustic surveys in Sweden and Lithuania was presented by Tomas Didrikas. The TS data came mostly from both 70 kHz (single beam) extracted with a modified Craig-Forbes routine and 38 kHz (splitbeam) sounders. A quick check with the KMR-modelling software indicated a TS-difference of less than 1 dB between 70 and 38 kHz for the fish size range considered. The relation indicates support for the idea of higher TS than assumed until now.

6 X-RAY DATA ON HERRING AND SPRAT FROM SWEDEN

A new set of X-ray-photos on 51 specimen of herring and 31 specimen of sprat caught in the northern and southern parts of Subdivision 25 during the Swedish October 2002 acoustic survey was presented.

Summary data is shown in Appendix B.

If quality is satisfactory the dimensions of the fishbodies and swimbladders will be traced and data used to complement the previous calculations of expected TS-values.

7 SAMPLE TS-DATA FROM DANISH R/V DANA CRUISE

Extracts from a set of acoustical survey data obtained in connection with an intensive trawling exercise (trawling app. every 3 hours on the same track for two days) were presented. Data were obtained on the Danish RV DANA in Subdivision 25 during March 2002. Data from this cruise and possibly available data, for example like those in mentioned in Paragraph 4 above, from other countries will be used to compare with the model predictions.

8 REPORTING

The report from 2002 has been corrected for minor printing errors and submitted to ICES.

This short summary of the 2003-meeting is submitted to ICES as well.

A more detailed report combined final draft report will be compiled within one year and submitted to the Fisheries Technology Committee by July 31st 2004. It is suggested that the report be submitted as a Cooperative Research Report.

9 ACKNOWLEDGEMENTS

The group thanks our Norwegian host for the fine arrangements and facilities during the meeting. The chairman thanks especially Thomas Didrikas and John Horne for help with taking notes and all the participants for contributing to an interesting meeting.

10 REFERENCES

Fleischman, S J and Burwen, D L (2000) Correcting for position-related bias in estimates of the backscattering cross-section. *Aquat Living Resour* 13: 283–290.

Hazen, L E and Horne J K (2003). A method for evaluating the effects of biological factors on fish target strength. *ICES J Mar Sci*, 60: 555–562.

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- Orlowski, A (1998) Acoustic methods applied to fish environmental studies in the Baltic Sea. *Fisheries Research* 34: 227–237.
- Stepnowski, A and Moszinsky M (2000). Inverse problem solution techniques as applied to indirect *in situ* estimation of fish target strength. *J Acoust Soc Am* 107 (5): 2554–2562.

See also SGTSEB 2002-report Chapters 5, 6, 8 and Appendix B.

11 APPENDIX A – ACRONYMS

CTD	Conductivity-Temperature-Depth measuring instrument
BIFS	Baltic International Fish Survey
ICES	International Council for the Exploration of the Sea
KRM	Kirchhoff-ray mode model
SGTSEB	Study Group of Target Strength Estimation in the Baltic Sea
TS	Target Strength
WGFAST	Working Group on Fisheries Acoustics Science and Technology
WGNEPH	Working Group on <i>Nephrops</i> Stocks
SD	Subdivisions of sea areas in ICES

12 APPENDIX B – TERMS OF REFERENCE OLD AND NEW

Brugge 2000

2B02 A Study Group on Target Strength

Estimation in the Baltic Sea [SGTSEB] (Chair: F. Arrhenius, Sweden) will be established and will meet in Seattle, USA from 22–23 April 2001 to:

a) prepare and disseminate as soon as possible a protocol for TS measurements on the Baltic herring, based upon the state of the art and especially the recommendations of the *Cooperative Research Report* on TS measurements, 1999), adapting these recommendations to the special case of the Baltic Sea;

Done (chapter 4, 2002-report)

b) establish a list of the main factors affecting the herring TS and study the effects through comparative analysis and measurements on various herring stocks (e.g. Baltic and Norwegian spring spawning herrings);

Initial assessment done in 2001 and 2002 reports. Modifications in process.

c) collate the existing information and measurements on herring TS;

Done

d) apply modelling methods on the case of the herring and compare their results to the existing information;

Modelling on herring and sprat done. Comparisons underway.

e) measure the variability of TS *in situ* under various conditions (day-night, wintersummer, etc.) using databases available from WGFAST members;

Only limited variations possible due to cruise pattern (spring-autumn only)

- f) encourage experimental measurements through conventional and non-conventional methods. SGTSEB shall make its report available to WGFASST and will report by 22 May 2001 for the attention of the Fisheries Technology and Baltic Committees.

Done

Oslo 2001

2B04 The Study Group on Target Strength Estimation in the Baltic Sea [SGTSEB]

(Chair: F. Arrhenius, Sweden) will meet in Sète, France from 7–8 June 2002 to:

- a) discuss the results of the biological properties that affect backscattering of Baltic fish, i.e., swim bladder volume and shape, fat content, and stomach content and fullness;

No in situ data obtained, but discussed in relation to model data from X-rayed fish.

- b) discuss the result of backscatter models, especially change in biological and physiological factors affecting the TS;

Done

- c) evaluate the single target TS measurements on herring and sprat during the 2001 surveys in the Baltic Sea;

Planned for final report using 2002 and possibly 2001 data.

- d) review the latest literature on TS of herring and sprat;

Done and continues.

- e) review current information of diel cycles of fat content and stomach fullness in different parts of the Baltic Sea area;

Done and continues.

SGTSEB will report by 30 June 2002 for the attention of the Fisheries Technology Committee.

Report delayed until 2003

Copenhagen 2002

2B04 The Study Group of Target Strength Estimation in the Baltic Sea [SGTSEB] (Chair: B. Lundgren, Denmark) will meet in Bergen, Norway from 17-18 June 2003 to:

- a) evaluate the single target TS measurements on herring and sprat during the surveys in 2001-2002 and from cage experiments in the Baltic;

Cage experiment tried but not successful. For survey data planned for final report.

- a) apply the modelling methods on the case of the herring and sprat and compare their results to the existing information and single target TS measurements and cage experiments in the Baltic Sea.

Planned for final report.

- a) recommend TS length relationships for herring and sprat in the Baltic Sea.

Initiated by 2003-meeting. Planned for final report.

SGTSEB will make its report available by 31 July 2003 for the attention of the Fisheries Technology Committee and the Baltic Committee. It will also make it available to WGFAST.

Preliminary meeting report being submitted. Final report within 1 year. Planned as Cooperative Research Report.

Supporting Information

Priority	The variability and trends on the TS of Baltic herring have been recognized as important
Scientific Justification	<p>The reasons and sources of variations are rather well documented and understood in the particular case of the Baltic Herring population. Although these sources of variation are particularly important in the case of the Baltic herring, it is clear that they are not specific to this population and that any result on this particular population would have potential application on other stocks.</p> <p>Due to the fact that (a) there is an urgent need of improving the definition of the TS of Baltic Herring (b) there is good knowledge of this population and (c) there are potentially good possibilities of measurements and experimentation on this fish, this population could be considered as a test population for the WGFAST members to understand and improve the meaning and value of target strength on pelagic fish.</p>
Relation to Strategic plan	Direct links to Goal # 1 and # 4
Resource requirements	None
Participants	Anticipate attendance of 8-10 persons. Appropriate members will attend the WGBIFS meeting in April 2003 to discuss these new ToR with Baltic acoustic colleagues and prepare the data for the Study Group meeting in 2003.
Secretariat facilities	None
Financial	No financial implications
Linkages to other Groups or Committees	This group is closely aligned to the FAST Working Group. WGBIFS
Linkages to Advisory Committees	There are no direct linkages to the advisory committees
Linkages to other organizations	
Cost Share	ICES 100%

13 APPENDIX C – SELECTED RECOMMENDATIONS FROM WGBIFS REGARDING FUTURE ACOUSTIC SURVEYING OF THE BALTIC

The full WGBIFS 2003-report can be found at <http://www.ices.dk/iceswork/wgdetailacfm.asp?wg=WGBIFS>

13.1 Acoustic surveys

The following important working items must be considered for the future and the WGBIFS therefore recommends that:

- The coverage of the autumn hydroacoustic survey by different nations in the Baltic Sea should be maintained at the actual high level. Additionally Subdivisions 29N, 30, 31 and 32 should be covered during future surveys.
- In order to get a complete picture of herring and sprat distribution in the Western Baltic area (Skagerrak, Kattegat, Subdivisions 22-24) the whole area should be covered at the same time. At present the Western Baltic area is covered by two separate surveys in different time of the year. One is carried out in July (Skagerrak, northern Kattegat) and the other in September/October (southern Kattegat, Subdivisions 22 to 24). The July survey is connected to the North Sea acoustic summer surveys whereas the October survey is linked to the Baltic Sea acoustic surveys.
- A standardized way to publish the data from the hydroacoustic surveys (WD "STRUCTURE OF CRUISE REPORTS FOR ACOUSTIC SURVEYS IN THE BALTIC SEA" by T. Groehsler, Appendix 8) has been tested and is recommended to be used for future acoustic cruise reports.
- The variability in the results of the acoustic surveys used for the assessment should be analysed.

14 APPENDIX D – SUMMARY OF A NEW SET OF X-RAY-PHOTOS

A new set of X-ray-photos on 51 specimen of herring and 31 specimen of sprat caught in the northern and southern parts of Subdivision 25

Origin

Fish samples: Swedish October 2002 acoustic survey with R/V Argos.

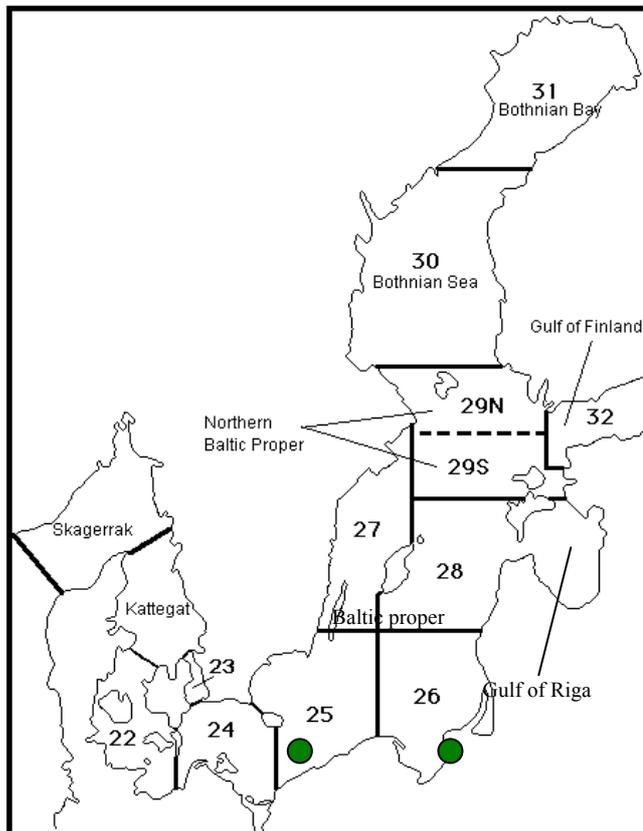
Nils Håkansson/Fredrik Arrhenius
National Board of Fisheries, Lysekil, Sweden

X-Ray Photography:

Swedish Museum of Natural History, Stockholm

Photo scanning:

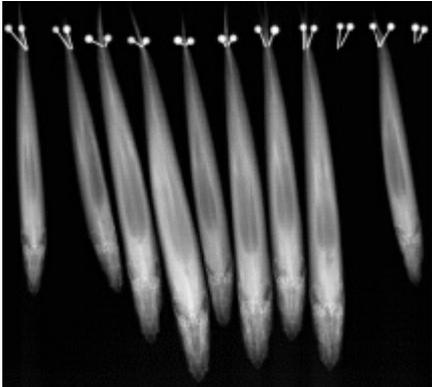
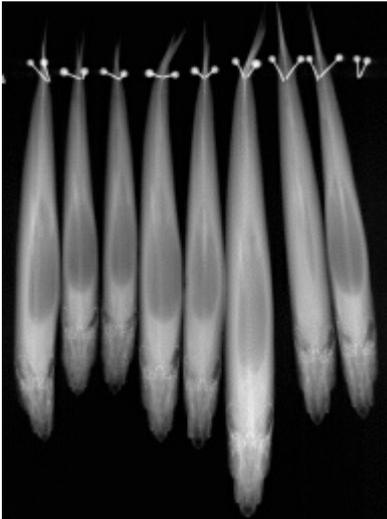
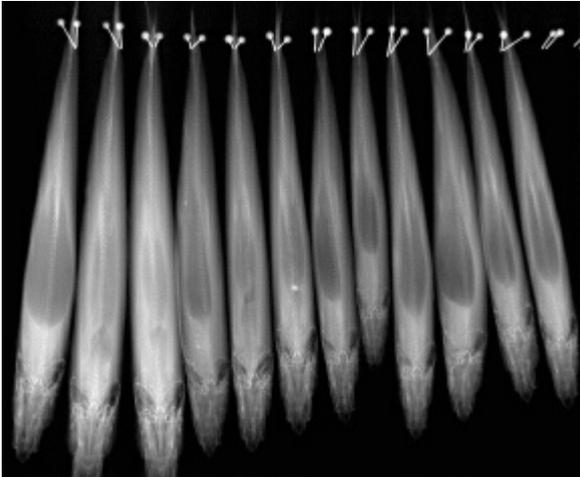
Bo Lundgren
Danish Institute for Fisheries Research, Hirtshals



Map of Skagerrak, Kattegat and the Baltic Sea. The approximate sampling positions are shown by the circles

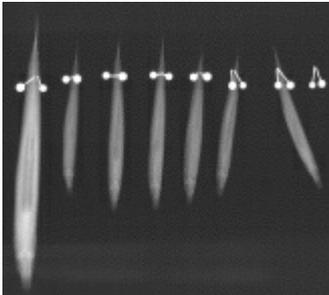
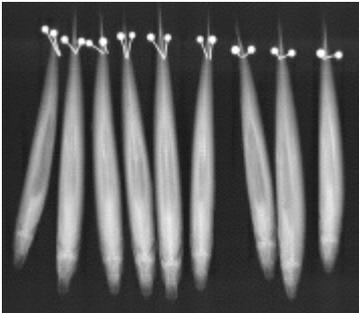
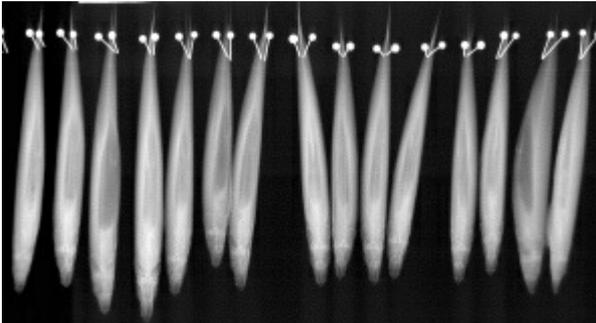
51 Herring

Size range 8 – 24.5 cm total length. Only dorsal view shown.



31 Sprat

Size range 7 – 12.5 cm total length. Only dorsal view shown



ACOUSTIC SURVEY 2002

Sampling of herring and sprat for X-ray analysis of the swimbladder

Anaesthetic bath: Dissolve 4–6 ml of clove oil solution (clove oil dissolved in ethanol in the ratio 9:1 (1:9, *I guess*)). Use a syringe or a Pasteur pipette to dispense the dose (The volume of the Pasteur pipette up to “the line” is about 2 ml).

Sample size:

Herring: 10 fish of each of three size classes (“large”, “medium”, “small”) from two different areas in the Baltic proper: southern part (Subdivisions 25 or 26) and northern part (north of Gotland, that is subdivision 29 or northern half of subdivisions 27 or 28) in all 60 fish.

Sprat: 10 fish of each of two size classes (“large”, “small”) from the two different areas, totally 40 fish.

Sampling procedure:

Take the fish directly from the conveyor belt below (*where the catch comes in*) (they must be alive and lively) and put them in a fish box with seawater. Don't put too many in the same box, rather use several boxes. Wait for a couple of minutes to make sure that the fish looks well and swim upright. Put them carefully in the anaesthetic bath with the help of a small net. When the fish has been anaesthetized, after 1 – 4 minutes depending on the size of the fish, they are taken up, numbered and measured (total length, standard length, height, and width). Then they are placed on a flat surface (for example a fish box) on greaseproof paper baking paper or alternatively plastic bags (the fish must not freeze on to the box) The box is put into the freezer and when the fish are frozen they are separately put into plastic bags. The bags are packed loosely – **the fish must not be damaged** - in boxes with lid. Use gloves when handling the anaesthetic, it may irritate the skin.

15 INVENTORY OF ACOUSTIC EQUIPMENT, SURVEY SHIPS AND PLANNED CRUISES FOR THE NATIONS DOING FISHERIES ACOUSTIC INVESTIGATIONS IN THE BALTIC SEA AREA

(From the WGBIFS-Meeting)

Acoustic equipment:

Country	Ship	Sounder	Frequency kHz	Transducer type	Transducer placement	Normal survey speed kn	Software
Denmark	Dana Special projects: Havfisker	2 x EY500 Plans for EK60	38 / 120	Split-beam	Hull or towed body	8 – 10	EY500-package Own judging software EP500 and EchoView
Estonia	Chartered commercial vessels (~24m)	EY500	38	Split-beam	Paravan	7	EY500-package
Germany	Solea	EK500	38	Single-beam	Hull		
Germany	Walter Herwig III						
Latvia	Chartered commercial vessels (~24m)	EY500	38	Split-beam	Paravan or rig fixed to vessel	7	EY500-package
Poland	Baltica	EY500?	38	Single-beam	Hull		
Russia	Atlantniro	EK500 Plans for EK60	38 / 120 200	Split-beam Split-beam	Hull	7 - 8	EK500 package EchoView 2.25
Sweden	Argos	EK500 Plans for EK60	30 / 120	Split-beam	Hull	10	EK500-package Bergen Integrator(BI) on UNIX

Other acoustic equipment:

Country	Ship	Equipment
Denmark	Dana	New sonar to be installed
Poland	Baltica	Wesmar TCS700C Sonar

Standard cruises(according to WGBIFS):

Country	Ship	Species	Area (ICES subdivisions)	Season
Estonia	Chartered commercial Vessel	Herring/ Sprat/Cod	28, 29, 32	October
Germany	Walther Herwig III		24, 25, part of 26, 27, 28	May
Germany	Solea		21, 22, 23, 24	Sept-Oct
Latvia	Chartered commercial Vessel		Part of 28	
Poland			24, 25, 26	October
Russia	Atlantniro		Part of 26	May
Russia	Atlantniro		26, Part of 28	October
Sweden	Argos		27 part of 25, 26, 28, 29S	October

Other cruises:

Country	Ship	Cruisetype	Season
Denmark	Dana	Occasional special ecology investigations in connection with BITS-surveys	March or November