Integrating spatial processes into ecosystem models for sustainable utilization of fish resources
INSPIRE

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INSPIRE Overview

Process-based understanding of changes in commercial fish spatial distributions, and to disentangle the role of natural drivers and various anthropogenic impacts, is a challenging research topic with high relevance to resource management. The very recently started four-years BONUS INSPIRE project will fill in the most persistent gaps in knowledge of the spatial ecology of the major commercial fish and thereby support the effectiveness of the relevant policies and ecosystem-based management of the Baltic Sea. The project would serve as a „*framework axis project*“ which other Baltic Sea research could be related to.

INSPIRE is designed to substantially advance our knowledge on the major commercial fish species – cod, herring, sprat and flounder, which represent key elements of the Baltic Sea ecosystems. The specific objectives of INSPIRE are to:

i. Quantify processes generating heterogeneity in spatial distributions of fish;
ii. Quantify and map potential hazards to the connectivity between identified key habitats, and assess the impact of anthropogenic and climatic environmental changes on habitat connectivity;
iii. Quantify the population dynamics and interactions of the fish species in a spatially explicit context;
iv. Develop spatially explicit advice for ecosystem-based fisheries management.

INSPIRE proposes pilot ecosystem integrated surveys to resolve the habitat requirements of different life-stages of fish species by combined use of traditional methods and application of modern advanced analysis techniques. The surveys are conducted in close collaboration with local fishermen.

www.bonus-inspire.org

Executive Summary

The current report provides information on the discussions held and decisions made at the third integrating workshop of INSPIRE. The overall aim of integrating workshops is to ensure timely discussions of important issues of the project to secure timely submission of project deliverables. The first workshop has focused on the integration between static distributions (WP1) and dynamics in the spatial distributions (WP2), the second workshop focused on the integration between dynamics in the spatial distributions and their scaling towards Baltic-wide population dynamics of the target species cod, herring, sprat and flounder (WP3).

The overall objective of this third integrative workshop has been to facilitate the flow between the first three work-packages and WP4, the implementation of the findings into stock assessments and agreeing upon partners responsibilities for performing concrete stock assessments. In addition to the primary objective, the meeting also reviewed the status of fieldworks and associated data analysis, discussed ideas for the high-profile paper and developed further ideas for the herring synthesis work.

The report below outlines the issues discussed and gives and overview on the state-of-the-art of the situation.

Introduction

Integrating workshops are seen in INSPIRE as venues to ensure effective and efficient linkage not only across the various work packages, but also to secure timely discussions on operational issues to achieve the project deliverables and aims, and balanced incorporation of all four fish taxa considered in the project (i.e. cod, flatfish, herring and sprat) into research activities. In total, there are four integrating workshops planned in the project.

The third integrating workshop of INSPIRE was held in Charlottenlund, Denmark during 25. September 2015 in connection to the ICES ASC. The meeting was hosted by the Technical University of Denmark, DTU-Aqua and co-convened by Stefan Neuenfeldt (DTU-Aqua) and Jan Horbovy (MIR-PIB). The meeting was attended by 24 participants, incl. members from BONUS BIO-C3 project.

Core activity

Agenda item #1: Welcome and housekeeping

The meeting host Stefan Neuenfeldt welcomed meeting participants (Annex 1) and introduced housekeeping rules.

Agenda item #2: Data issues

In order to facilitate access to the data gathered in INSPIRE, a network data server has been installed. All INSPIRE scientists have writing access to the data upload area. The uploaded data will be distributed in different sub-directories, for which the INSPIRE scientists have reading access. The upload procedure has been discussed and a short manual will be distributed shortly after the meeting.

Agenda item #3: A Bayesian network approach to the management of Baltic Fisheries (*by Thorsten Blenckner*)

The management of the Baltic fisheries has previously focused on dynamics that are limited in terms of spatial and temporal interactions. Research suggests that the interaction between habitat and trophic interactions combined with environmental influences are required. Using a data driven approach within a Bayesian network model our research has been able to highlight the complex situation in the Baltic Sea. The model is based on the information observed for each of the twenty seven thousand fine scale habitat polygons. This information consists of structural (depth, distance from Baltic sea mouth, rugosity and habitat type), environmental (Spring and Summer temperatures, phosphate and nitrate concentrations, salinity, anoxic levels), trophic (various plankton groups, macrozoobenthos, benthic biomass of flatfish, herring, sprat and cod, pelagic biomass of sprat and herring) and the level of Baltic cod catches. Modeling the non-stationary dynamics through 41 years highlights the role of environmental and trophic changes on Baltic cod biomass. The widely published series of events that led to the demise of the fisheries is supported but the role of sprat as a direct influence on cod is difficult to determine. Critically this modeling approach is able to examine the dynamics at a fine spatial resolution and with an indication of the certainty of the model predictions. The state of cod in each habitat polygon can be determined from a limited suite of Baltic Sea observations. The non-stationary nature of the model highlights that fisheries management needs to account for structural and environmental factors in an evolving trophic system.

Agenda item #4: Short overview on field sampling and collected material

Cod and flatfish surveys 2015 (*by Karin Hüssy and Ann-Britt Florin*)

All gillnet transects have been fished during spring but some stations had to be omitted in some occasions due to bad weather conditions. Overall there is good coverage of collected data for environmental variables and abundance of flounder and adult cod. In total 2564 flounders and 1023 cod above 20 cm was registered. Still juvenile (< 20cm) cod is very rare and only 74 were registered. Videos from all transects are now being collected for analyses by SLU Aqua.

2015 beach seine survey was performed according to plan. However very few 0-group flounder were caught in Germany. Estonia and Finland and also in Sweden the numbers of 0-group flounders were very much reduced comparing to 2014. Only Latvia there was a large number of 0-group caught but still this was fewer compared to the results 2014.

For more information, see Annex 2.

Stock identification of flounder (*by Ann-Britt Florin*)

Reference samples of adult flounders of both ecotypes (coastal spawning with demersal eggs and offshore spawning with pelagic eggs) from the 2014 and 2015 gillnet surveys in the Gotland deep and Hanö bight have been collected. In addition tissue samples and otoliths have been taken from adult flounders as well as juvenile flounders from all fished transects all. Genetic analysis have started and will be continued during 2015 and also otolithchemistry will be performed on a subset of these flounders.

Hydroacoustic surveys 2015 (*by Georgs Kornilovs*)

- Timing: September 2015 (in June in 2014)
- Duration: each 3 days long

- Location of the works: Sub-division 28 in area with stable concentrations of pelagic fishes;
- Survey team: researchers from BIOR;
- Acoustic recording;
- 9 day time and 2 night time trawls in different water layers.
- Aim: a) to determine the influence of the trawling horizon on the proportion of sprat and herring in the samples; b) To determine the influence of the trawling time (daytime or night) on the proportion of sprat and herring in the samples; c) to collect material on the vertical distribution of sprat in dependence from daytime and age.
- Additional tasks: Observation of the formation of pelagic fishes schools.

Ichthyoplankton surveys 2015 (*by Georgs Kornilovs*)

- Timing: May 2015 during the hydro-acoustic survey and June 2015 (the same as in 2014);
- Duration: 13 days in May and 8 days in June;
- Location of the works: Sub-divisions 28 and 29, western part of the Gulf of Finland;
- Survey team: researchers from BIOR (Latvia) and EMI (Estonia)
- Aim: a) to determine the main spawning and larvae distribution areas in the north-eastern Baltic; b) to determine the importance of different areas of the north-eastern Baltic for the reproduction of sprat; c) To determine whether there are differences in the growth, condition and survival of sprat larvae between different areas of the north-eastern Baltic Sea.

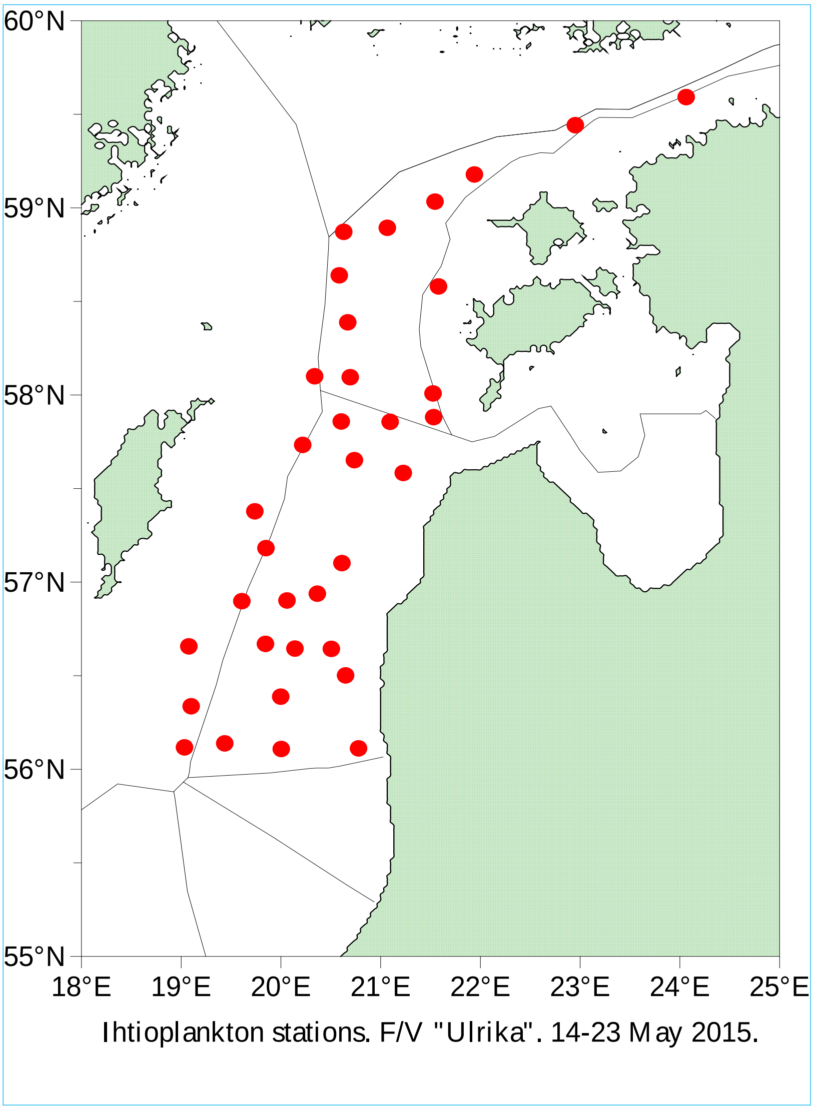


Figure 1. Ichthyoplankton sampling in May 2015. In total, 70 ichthyoplankton samples were collected in 35 stations by IKS-80 net.

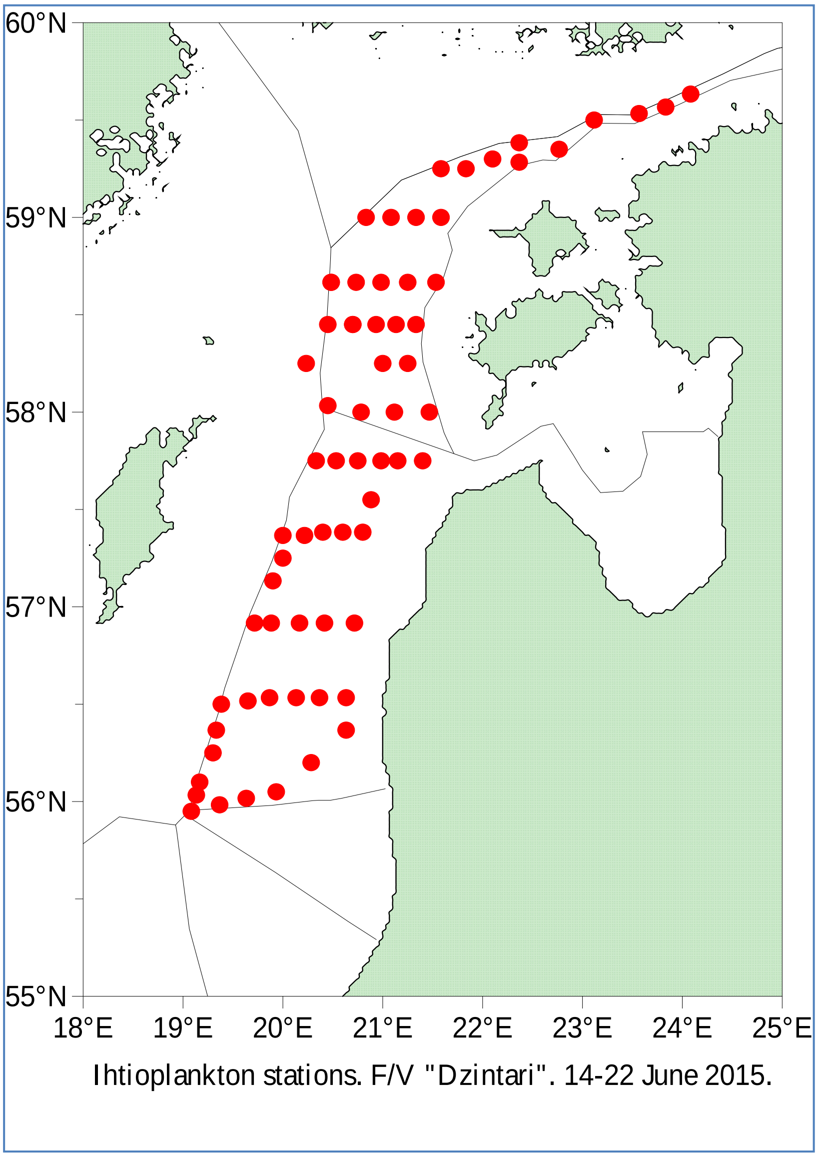


Figure 2. Ichthyoplankton sampling in June 2015. In total, 128 ichthyoplankton samples were collected in 67 stations by IKS-80 net.

Survey of feeding conditions and feeding of pelagic fishes 2015 (*by Georgs Kornilovs*)

- Latvian-Estonian joint survey in 10-15 July 2015 on board of f/v„ULRIKA"
- Trawl survey on 5 transects in Subdidsions 28.2, 29 and 32
- Trawl hauls on dense schools

- CTD survey, vertical zooplankton samples and stomach samples of herring and sprat at 12 stations were collected.
- Altogether app. 840 of sprat stomachs and 720 of herring stomachs were collected.
- Otoliths were taken in all fish.
- Zooplantkon and fish stomach samples will be analysed by EMI-UT by the end of 2015.

Figure 3. Location of five sampling transects.

Agenda item #5: INSPIRE findings contributing to cod assessment problems (*by Karin Hüssy and Stefan Neuenfeldt*)

Ageing problems:

The age-based assessment of eastern Baltic cod has since 2014 not been accepted owing to the massive ageing problems evident within the stock. This has also implications for WP4 of INSPIRE. A thorough review of all historic documents dealing with the ageing problem in peer-reviewed literature and study group as well as assessment working group reports had been carried out (submitted as paper to ICES Journal of Marine Science). The key issues of this review were highlighted during the INSPIRE workshop.

Since the implementation of an age-based assessment of the Baltic cod in the beginning of the 1970's, it has been clear that the assessment is hampered by the quality of the age composition data. The reason for the age reading problems is the low visual contrast between growth zones in the otoliths which seems to be **the result of the complex hydrography of the eastern Baltic Sea with respect to thermal stratification, seasonal variation in food consumption coupled with the individual fish's vertical migrations, spawning behaviour and the prolonged spawning period.** Over the last 40 years various expert groups have invested extensive efforts to map the conformity of age estimation between otolith readers, standardise methods and age interpretations through repeated exchanges and reference collections as well as an internationally agreed manual. Despite all initiatives the precision of the age estimations based on traditional ageing did not improve, with significant bias persisting between readers and even with inconsistencies within readers. Why the problem seems to have increased in recent years is still unclear.

For more information, see Annex 3.

Growth problems:

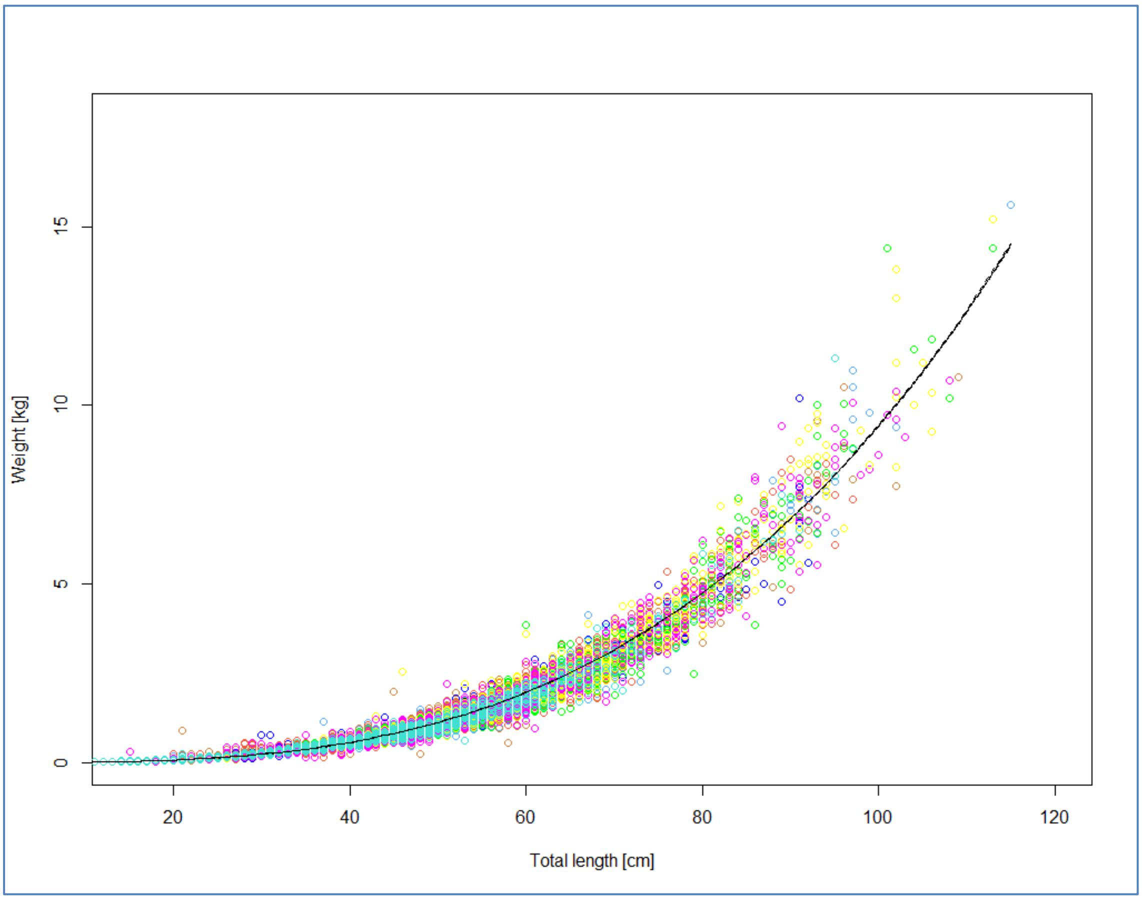


Figure 4. Cod weight at length for about 20 000 data points in the Bornhom Basin, colours indicate different years, from 2002 to now. From this perspective, there is obviously no change in weight at length, however, the variance band appears to differ from year to year (can have multiple causes).

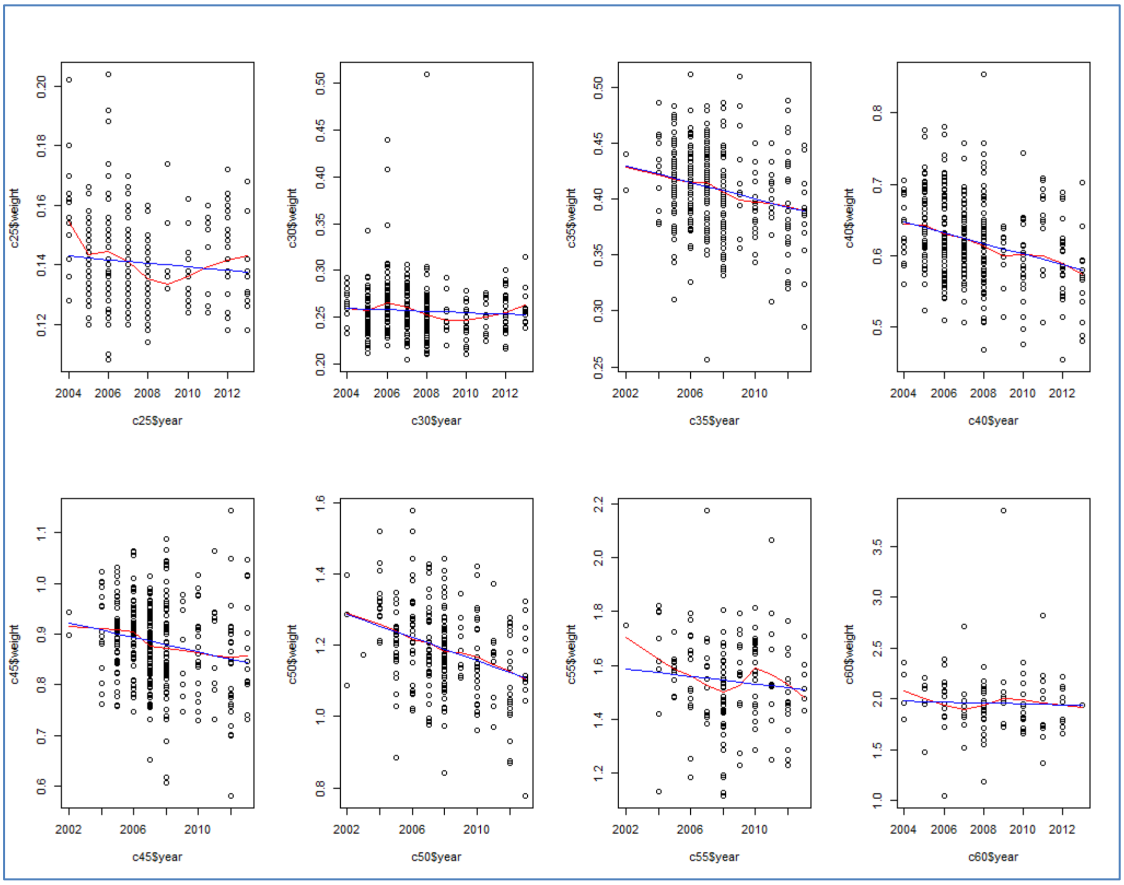


Figure 5. Cod weight at a given length group, c25 e.g. indicates 25 cm total length cod, over time. Red line: LOESS fit, blue line: linear regression.

Above the length in a given cm group in a given year versus weight. The very much discussed decrease in weight at length (or condition) starts (during life history) between 30 cm and 35 cm total length, and stops again at length >55 cm (in the first plot only visible part of the changes in the variance band). From the available time series back to 2002 it is not identifiable, when this phenomenon started. Scanning Swedish data, implies that the decrease in condition for cod between 30 cm and 55 cm started sometimes in the late 80s, that is when the inflow stagnation really had kicked in (last inflow then 1983, no one until 1992). However, there was plenty of sprat available at that period.

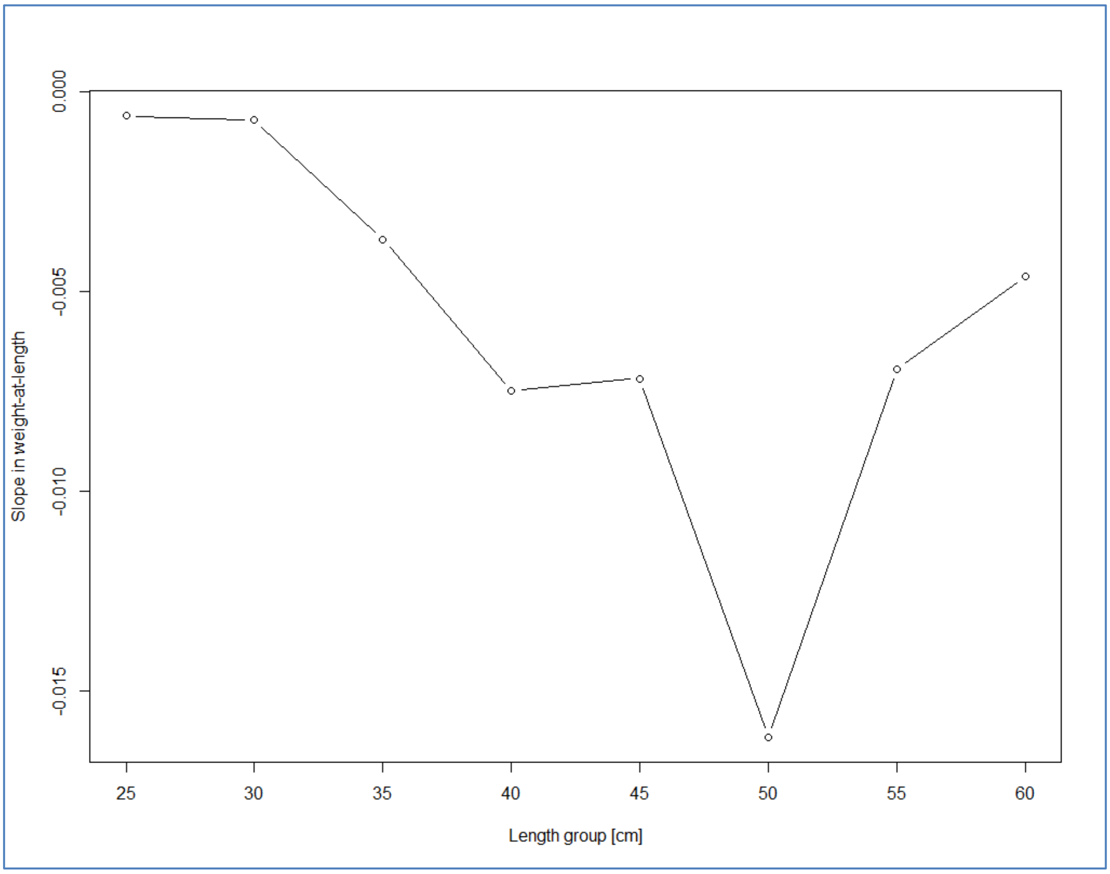


Figure 6. Slopes of the linear regression lines of weight at length over time from figure 5.

These are the slope of above linear regression lines plotted against length. Just to underline the decrease from 30 cm to 50 cm length.

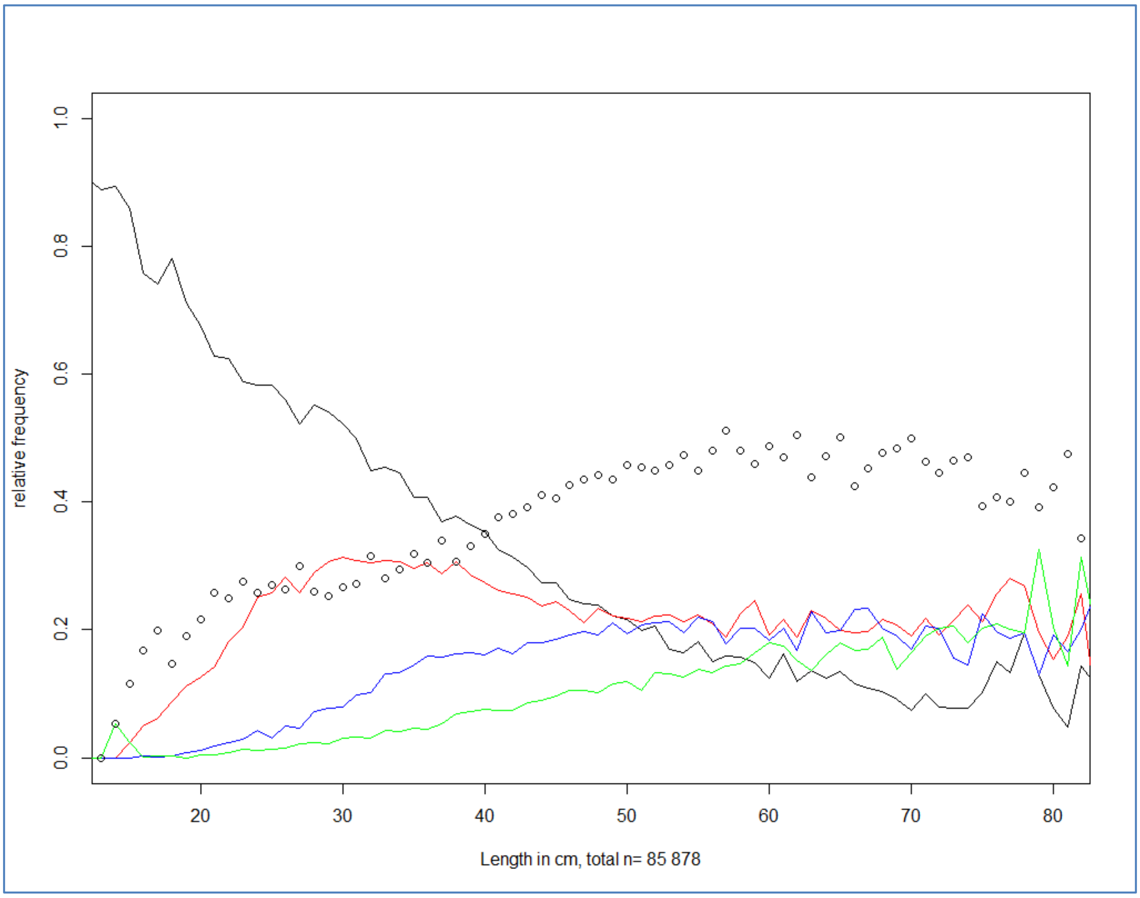


Figure 7. Diet composition, expressed as frequency of occurrence of different prey types over cod length. Black dots: frequency of empty stomachs (note that there are two plateaus, one between c. 25 cm and 40 cm, and another above 50 cm). Black line: benthos except for *Saduria entomon* (Polsk fladbukkel). Red line: *S. entomon* (always in the stomachs at constant frequency above 15 cm length; mouth too small before). Blue line: sprat (coming in slowly between 20 cm and 40 cm). Green line: herring (coming in later than sprat; they are on average bigger).

The range above 55 cm with no decrease in weight at length is easily identifiable. Full range of food items in the diet, very flexible, able to go for benthic fish, too. The range between 30 cm and 50 cm is characterized by the successive change from demersal to pelagic (herring and sprat) feeding. If the decrease in weight at length started at times when there were enough herring and sprat, it is probably caused by too low condition to initiate pelagic foraging, or no overlap between cod and sprat (primarily, because it is sprat they start foraging on, herring comes later in their life, because it is bigger).

We will now look at the stomach data to see, if there is support for the hypothesis that decrease in weight at length is due to decreased sprat in the transitional period between demersal and pelagic foraging. In case, we also will see, if this can be explained by change in the benthos diet, simply less or worse quality in terms of energy content.

Agenda item #6: High profile paper (*by C. Möllmann and S. Neuenfeldt*)

The INSPIRE consortium wishes to highlight the major thought behind the INSPIRE project in a high-level paper, basically a comment to a globally respected journal. The major thought is that spatially explicit multi-species assessment and management are crucially necessary for a successful ecosystem-based fisheries management.

The manuscript on the need of considering spatial heterogeneity in ecosystem-based management [with the Baltic as the case stduy]. It could be a policy forum in SCIENCE or comment in NATURE

Agenda item #7: Concrete stock assessment workplan (*by J. Horbovy*)

The commitments on the stock assessment taken by the Consortium and described in the DoW were presented and discussed in details by the group. Issues of inclusion of INSPIRE survey results into assessment were considered. Taken into account current problems with the eastern cod assessment, the group confirmed extension of some of its activity towards eastern cod assessment – such activity was not planned in DoW. These cod assessment problems are new and were not known neither at the time when INSPIRE application for BONUS was developed nor during the project negotiation process.

Workplan for stock assessments was distributed prior to the meeting and discussed/amended/further developed. In Table 1, for each stock or group of stocks the following is presented:

- Challenges for stock assessments / management,
- Solutions for solving problems, including the proposal for the models or methods to be used to solve the problems
- Partners responsibilities for the preparation of the analyses,
- Partners involved in the work and the deadline for performing analyses.

For some of the analyses it was suggested to apply methods similar to management strategies evaluation. It was mentioned that there are quite complex natural mortality models in the literature and they could be attempted to be applied for eastern cod.
Important issue for flatfish assessments are estimates of discards. However, they are only partly available, usually from most recent years and obtaining historical series may not be possible. For the gaps in the estimates of discards it was suggested to try methods used previously for estimating unallocated catches (e.g. Robin Cook method). In addition, sensitivity analyses of assessments with different discard levels should be performed.

Table 1. Detailed workplan for fish stock assessments.

Stock	Description of the problem, what should be solved	Planned approach/model to be used for solving the problem	Responsible Institute	Expected completion time	Comments
<u>All stocks</u>					
cod, herring, and sprat in the Baltic	recent spatial and temporal changes in stock distribution are not accounted for in the current assessments	1. Spatially disaggregated multispecies model (based on SMS forecast module, including prey-dependent growth and improved food selection and differentiating the different basins in the Eastern Baltic).	DTU-Aqua	2016, q2	The model I intend to use is based on Rudi's matlab model. We can include biological processes, such as recruitment per basin, spatial overlap asf. I hope we will be able to make a second stage that is length-based and includes prey-dependent growth

		2. estimation of spatial overlaps between species and life-stages for inclusion in single- and multi-species models	SLU	2016, q2	Related to point 1 (inclusion in the models).
<u>**Cod**</u>					
eastern Baltic cod, sub-div. 25-32	failure of assessments models applied up to 2013, no alternative accepted analytical assessment, huge change in biological parameters	1. usage of models with M varying (increasing) in recent years (e.g. with M related to condition, weights, parasites)	MIR-PIB	2015, q4	
		2. consideration of bias in age reading	MIR-PIB	2016, q2	
		3. other approaches for cod, M from formulae provided by Margit Eero	DTU-Aqua/MIR-PIB		
<u>**Herring**</u>					
herring 25-29,32	Up to beginning of 1990ies several stocks were defined for the present Central baltic herring (Sd 25-28.2, 29&32)by ICES: herring in 25-27 & herring in 28-29S, herring in 29N, herring in Sd 32. Next, combined assessment unit in sub-div. 25-29,32 was used. The SGHAUB (2001-2003) distinguished 3 components in its experimental assessments: herring in Sd 28.2, 29 and 32; southern coastal herring (Sd 25-26) amd Swedish coastal herring (Sd 25-27).The	1. XSA analyses of separate and merged stocks/assessment units; simulations of catch and biomass predictions in excel or in R, possible use of FLR	MIR-PIB; EMI-UT; LUKE; BIOR, SLU	2016, q3	The plan is to repeat the analyses for the historically defined stocks and their combinations (4): Sd. 25-27; Sd 28.2, 29, 32; Sd 28.2, 29; Sd 32

	question: is stock dynamics in combined assessment unit similar to stock dynamics in former units? How merging the former units effects biomass estimates compared to previously defined units? How it effects stock and catch projections?				
herring in 25-29,32 and herring in 22-24+IIIa	Exchange between herrings in western Baltic and central Baltic has been observed and documented basing on parasitic infestation and/or growth parameters. However, such exchange is not taken into account in present assessments. The question: how this exchange effects present assessment and catch projections of herring stocks ?	1. Model developed by Horbowy (2005), simulations in excel or in R	MIR-PIB, EMI-UT	EMI-UT: Not before 2016 q2; MIR-PIB, 2017, q1	
	Insufficient information on proportions of WBSS and CB herring in catches from 22-26 requires research on methods to better evaluate the magnitude of mixing of those stocks. The analyses clearly showed intensive mixing of WBSSH and CBH at least in the ICES SDs 24, 25 and 26 with variable proportion of WBSSH from year-to-year. Therefore, the incorporation of the WBSSH in the ICES SDs 25 and 26 into the stock indices of WBSSH will improve the	Application of the stock separation function (SF) (Groehsler et. al 2013) on international hydroacoustic data (IBAS) in ICES SD 21-32 to 1) quantify the degree of WBSS/CBH stock mixing in autumn, 2) evaluate the relevance of stock mixing for assessment purposes and 3) evaluate the validity of this and alternative separation methods.	TI-OF	2016 q2	A requirement is the provision of BIAS hydroacoustic data (2001-2014) from nations involved (the agreement in ICES WGBIFS was to provide R. Oeberst with data until 1st July 2015)

	description of the dynamics of the WBSSH. On the other hand, CBH in the ICES SD 24 should be taken into account during the estimation of stock indices of CBH.				
<u>**Sprat**</u>					
sprat 22-32 25-29,32	Up to beginning of 1990ies three sprat stocks were defined by ICES: sprat in 22-25, sprat in 26+28, and sprat in 27, 29-32. Next, combined assessment unit in sub-div. 22-32 was used. The questions: is stock dynamics in combined assessment unit similar to stock dynamics in former units? How merging the former units effects biomass estimates compared to estimates from previously defined units? How it effects stock and catch projections?	1. XSA analyses of separate and merged stocks/assessment units; simulations of catch and biomass predictions in excel or in R, possible use of FLR	MIR-PIB, LUKE	2016, q4	The plan is to repeat the analyses for the historically defined stocks and their combinations: Sd. 29-32
<u>**Flatfishes**</u>					
Flounder 22-23, pelagic			DTU-Aqua		
Flounder 24-25, pelagic	so far there is no accepted analytical assessment of the stock	1. age structured assessment	MIR-PIB	2016, q4	
		2. stock-production models (attempts to include Bayesian approach or approach with F treated as random walk)	MIR-PIB	2016, q4	
	extent of demersal flounder in area	1. Stock ID analysis, genetics,	UU, SLU	2016, q4	

	uknown	morphology, otolithchemistry, reproductive characteristics		
Flounder 26+28, pelagic	so far there is no accepted analytical assessment of the stock	1. age structured assessment	BIOR	2016, q4
		2. stock-production models (attempts to include Bayesian approach or approach with F treated as random walk)	BIOR	2016, q4
	extent of demersal flounder in area uknown	1. Stock ID analysis, genetics, morphology, otolithchemistry,reproductive characteristics	UU, SLU, BIOR	2016, q4
Flounder 27,29-32, demersal	so far there is no accepted analytical assessment of the stock	1. age structured assessment with survey data?	SLU, UT-EMI	2016, q4
		2. other exploratory assessment methods, such as Spawning Potential Ratio	SLU, UT-EMI, LUKE	2016, q4
<u>All flounders</u>				
	Flounder management is presently based on survey indices (data poor stock approach). Would analytical assessment and projections improove management ? What would be the difference between both managements ?	1. Evaluation and comparison of management strategies with two approches for flounder assesments: (1) analytical models, (2) survey indices		
		a) developement of approaches/methodology		2017, q2
		b) conducting the analyses		2017, q3

Sub-group work (*by P. Polte and C. Möllmann*)

<u>1. Pan-Baltic review paper on herring recruitment ecology</u>

To collect historic knowledge and –data sets on herring ecology in the Baltic Sea is considered an important task to detect changes of ecosystem functioning on a Baltic Sea scale. This knowledge is essential as a baseline required for evaluation of distribution shifts or any changes of factors affecting herring recruitment. Especially along the multi- national shores of the Baltic Sea it is a unique and valuable approach to synthesize the available literature published in numerous languages into one strictly hypotheses orientated effort.

The review is considered to include two major parts:

i. Review of grey literature in national languages. Each partner is supposed to summarize major findings in his/hers mother tongue into short “Abstracts” (with the original references given).

ii. Retrieving historical data sets and published references for detailed analyses of similarities/differences of herring ecology (more specific early life stage dynamics, migration patterns, fecundity etc.). A central aim of this analysis is feeding the historical data into a generic stock-recruitment model Baltic Sea herring.

- An approach would be to compare the major stressors of herring recruitment between multiple basins along the hydrographic gradients of the Baltic Sea. Comprehensive sets of environmental variables will be tested by multivariate means to identify major drivers of larval survival.
- Quantifying effects of regional hazards on larger scale productivity and spatial distributions
- WP 3 includes collecting basic knowledge on regional stressors for population dynamics of Baltic fish populations. The focus is on a quantification of effects transported from regional scale nurseries and spawning grounds to larger scale productivity and spatial distributions. A major challenge is to evaluate the importance of particular retention areas to the total population and to analyze local scale mortality and the impact on higher spatial scales.

<u>2. A generic, analysis of drivers and stressors of herring recruitment throughout basins and populations</u>

Objective of the study: identification of large scale vs. small scale drivers by analyzing similarities and differences of larval herring dynamics and their response to environmental variables along the Baltic Sea gradients. Basin scale environments and biological repose variables, such as larval abundance and larval cohort dynamics are planned to be analyzed in multiple basins along the Baltic Sea. This is a novel approach to understand the specifics in herring ecology and hence isolate the drivers affecting recruitment in multiple areas. This is bases on the major hypothesis that herring early life +history in the Baltic Sea is subjected to a quite different suite of drivers than stocks in the neighboring North-East Atlantic.

Hypotheses to be addressed include:

- Similarities in biological response hint on generic drivers of Baltic Sea herring production
- Large scale climate regimes are not dominating over local scale stressors (e.g. eutophication) driving the dynamics of fish and zooplankton communities throughout Baltic Sea gradients and herring populations

Methods:

- Stock-/recruitment models for each BS herring stock (Analysis of similarities/differences between stocks)
- Structural equation modeling of variables structuring recruitment success

Challenges:

- Differing time series, seasonal sampling campaigns etc. between countries
- Different spatial scales
- Different degree of ecosystem understanding.

Annex I. List of participants

No.	Name	Institute
1	Andrushaitis Andris	BONUS secretariat
2	Bergström Ulf	SLU
3	Blenckner Thorsten	SU
4	Casini Michele	SLU
5	Eero Margit	DTU-Aqua
6	Eriksson Pehr	Baltic Sea RAC
7	Florin Ann-Britt	SLU
8	Horbovy Jan	MIR-PIB
9	Hüssy Karin	DTU-Aqua
10	Kallasvuo Meri	LUKE
11	Kornilovs Georgs	BIOR
12	Lehmann Andreas	GEOMAR
13	Luzenczyk Anna	MIR-PIB
14	Möllmann Christian	UHAM
15	Neuenfeldt Stefan	DTU-Aqua
16	Nissling Anders	UU
17	Orio Alessandro	SLU
18	Ojaveer Henn	UT-EMI
19	Polte Patrick	TI-OF
20	Radtke Krzysztof	MIR-PIB
21	Raitaniemi Jari	LUKE
22	Ustups Didzis	BIOR
23	Fey Dariusz	MIR-PIB (BONUS BIO-C3)
24	Margonski Piotr	MIR-PIB (BONUS BIO-C3)

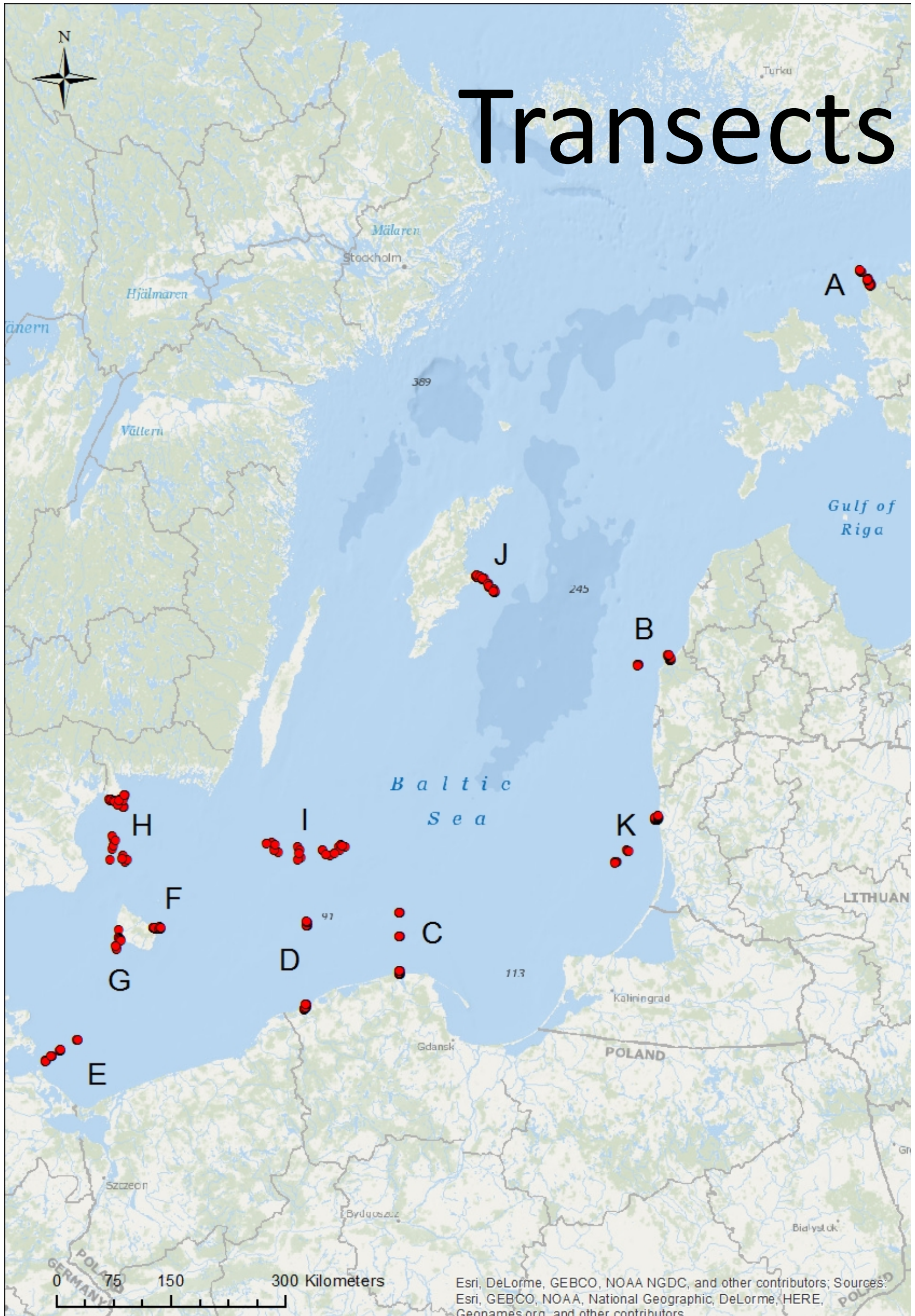
Annex 2

Results from the gillnet survey

BONUS - INSPIRE

INtegrating SPatial pROcesses into Ecosystem models for sustainable utilization of fish resources

Transects performed

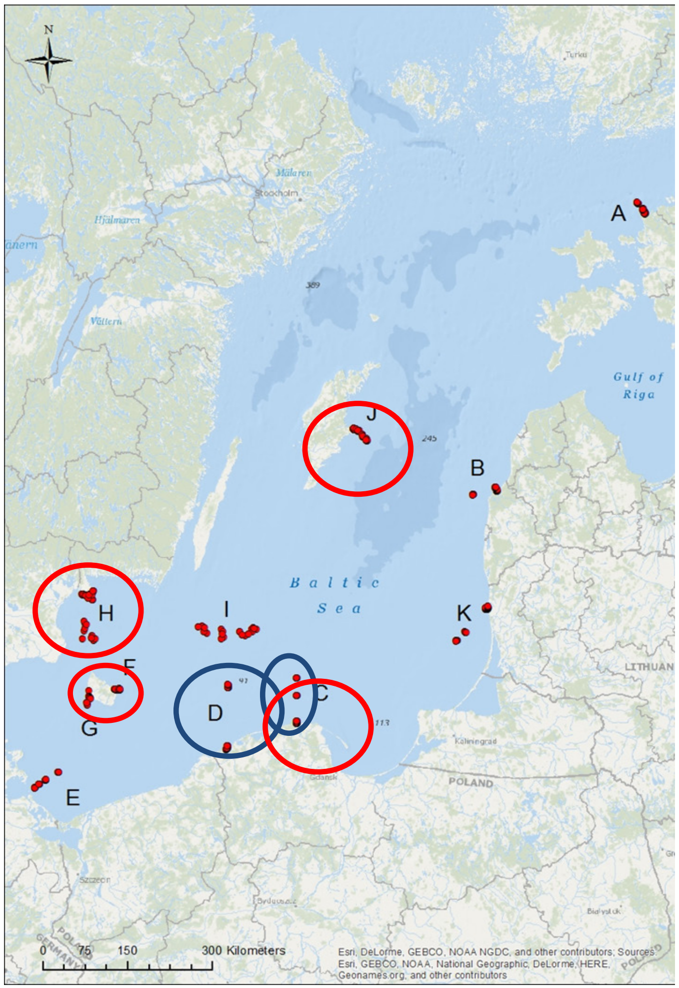


- Spring: all transects fished
- But stations reduced in:
- North of Bornholm (F) to 15
- South of bornholm (G) to 12 stations
- Hanöbay (H) to 21
- Midsjöbanken (I) to 10 stations

Parameters recorded - spring

Transect	Total	Fished	Wind speed	CTD	TEMP	PSU	O2	Secchi	Habitat fil
A	25	25	25	25	25	25	25	25	25
B	20	20	20	20	20	20	20	20	20
C	25	25	25	15	25	25	25	25	12
D	25	24	24	14	24	24	24	24	8
E	20	20	20	16	16	16	15	20	20
F	25	15	15	15	13	13	13	15	15
G	15	12	12	12	11	11	11	12	12
H	25	21	21	21	21	21	21	21	18
I	20	10	10	10	10	10	10	10	10
J	25	25	25	25	25	25	25	25	20
K	25	25	25	0	25	25	25	25	25
	250	222	222	173	215	215	214	222	185
		89%	100%	78%	97%	97%	96%	100%	83%

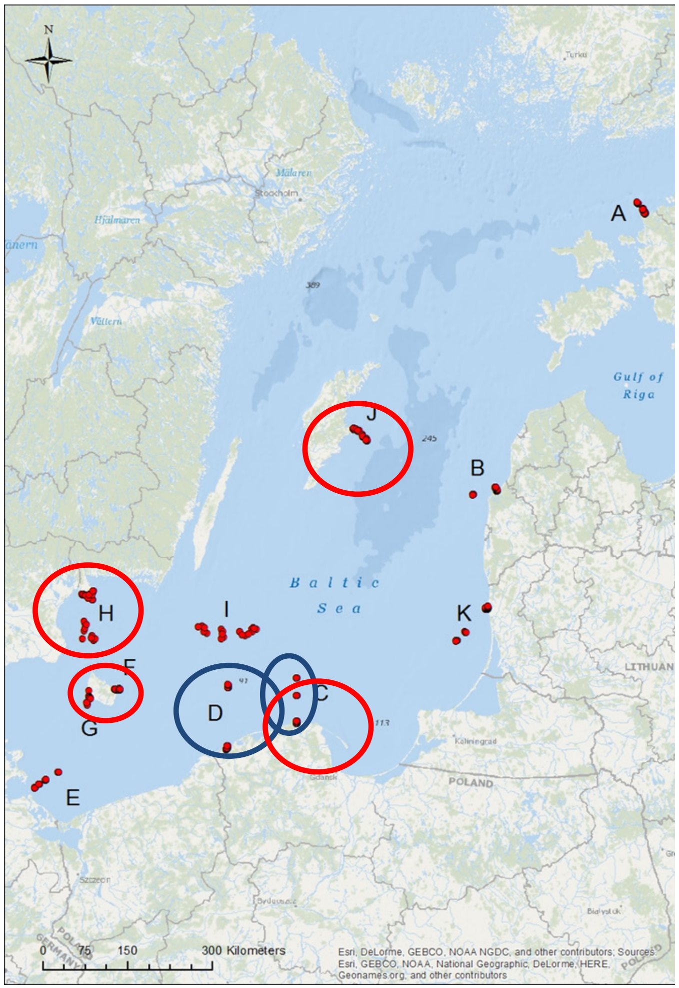
Cod & Flounder



Spring

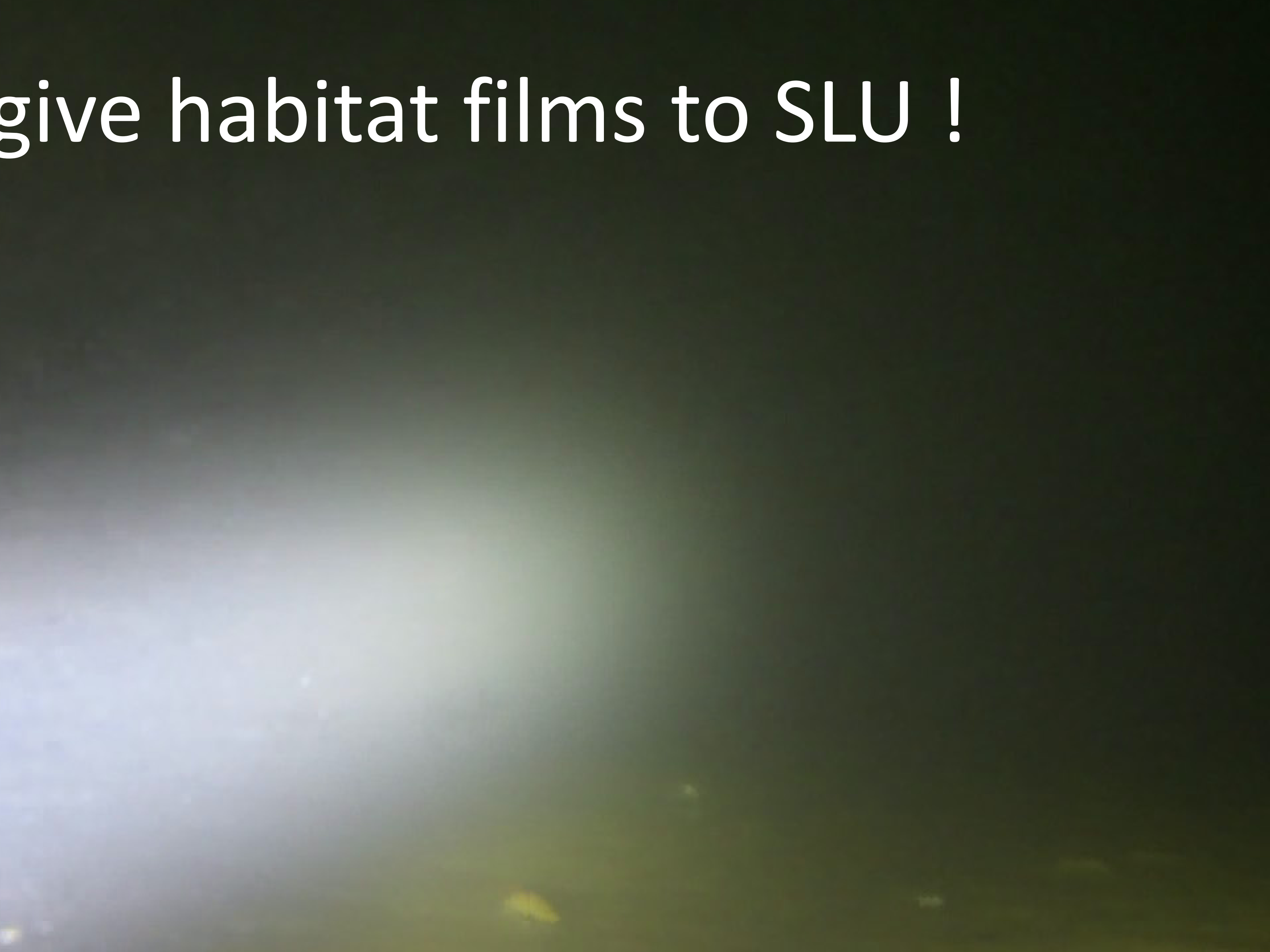
		# flounder	#cod<20cm	#cod>20cm
SD32	A	36		5
SD28	B	71	1	55
SD26	C	367	33	175
SD26	D	97	13	188
SD24	E	193	1	39
SD24	F	341		108
SD25	G	96		63
SD25	H	360	1	167
SD25	I	34	2	88
SD28	J	418	1	38
SD26	K	55	3	89
	Total	2564	74	1023

Cod & Flounder



Spring

	# flounde	#cod<20c	#cod>20c
5	259	0	78
10	378	1	154
20	483	12	253
50	283	7	282
70	580	35	179

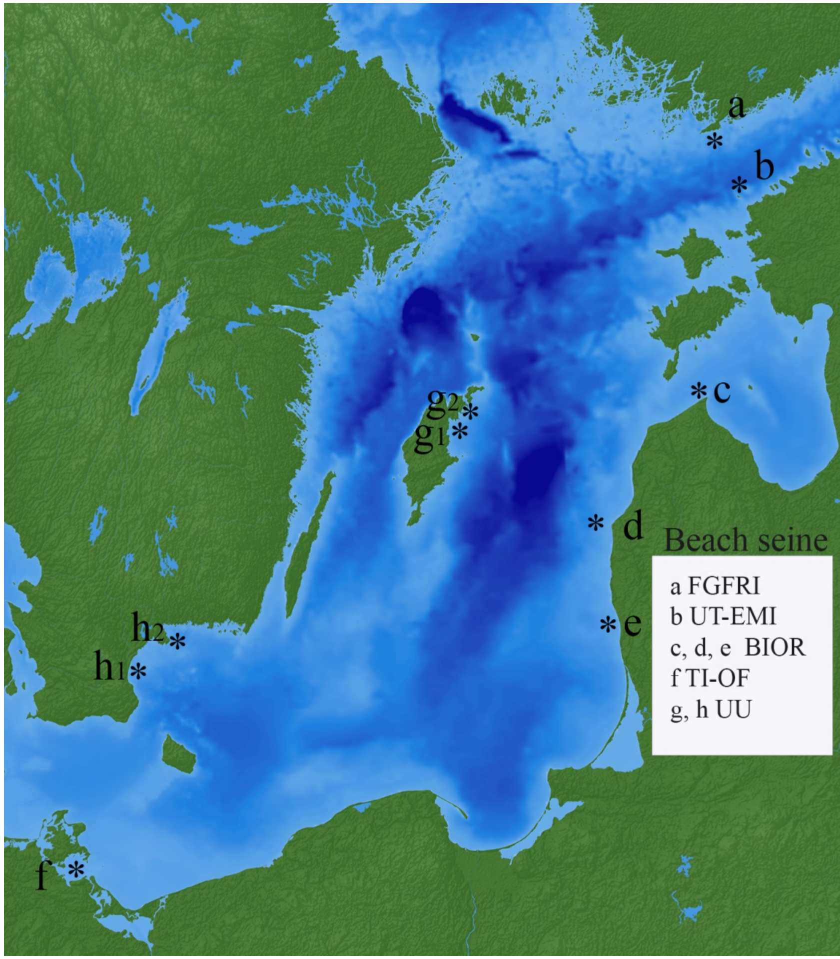

give habitat films to SLU !

Beach seine surveys

Sweden, Finland, Estonia, Latvia, Germany

Sampling

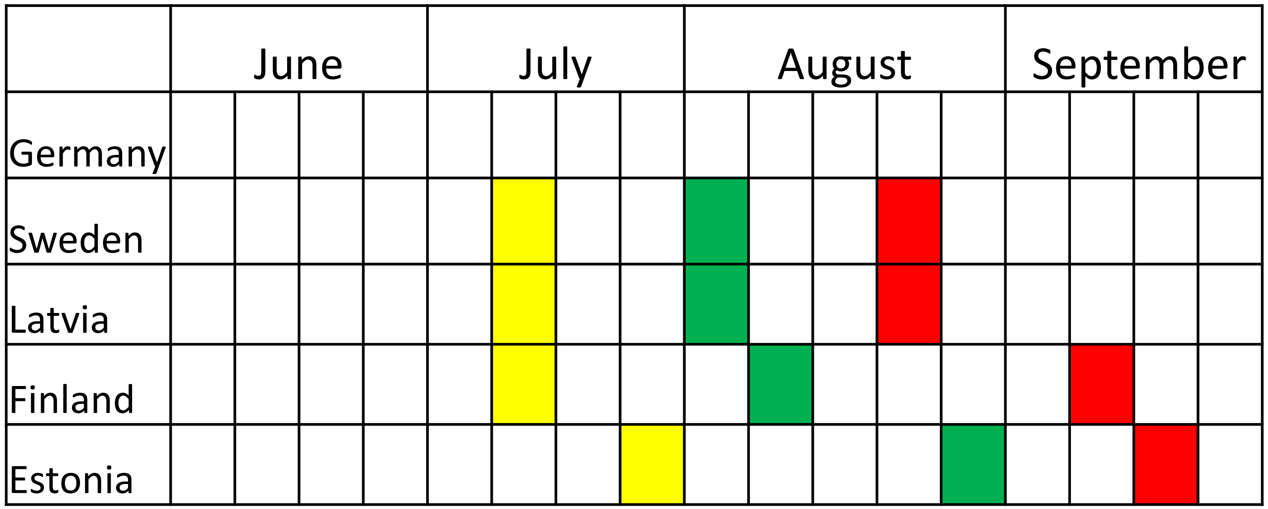
- Sweden 2, Germany 1, Latvia 3, Estonia 1 and Finland 1
- At 0.2, 0.6 and 1 m depth with (normally) 5 hauls per depth; i.e. 15 hauls per location
- Coverage of each haul, ca 120 m^2
- At three times per year (see below)
- Sampling is made during mid to late summer in order to target arrival of 0 group flounder to nursery areas.
  - Mid July,
  - early August
  - late August/early September



Sampling

- Sweden 2, Germany 1, Latvia 3, Estonia 1 and Finland 2

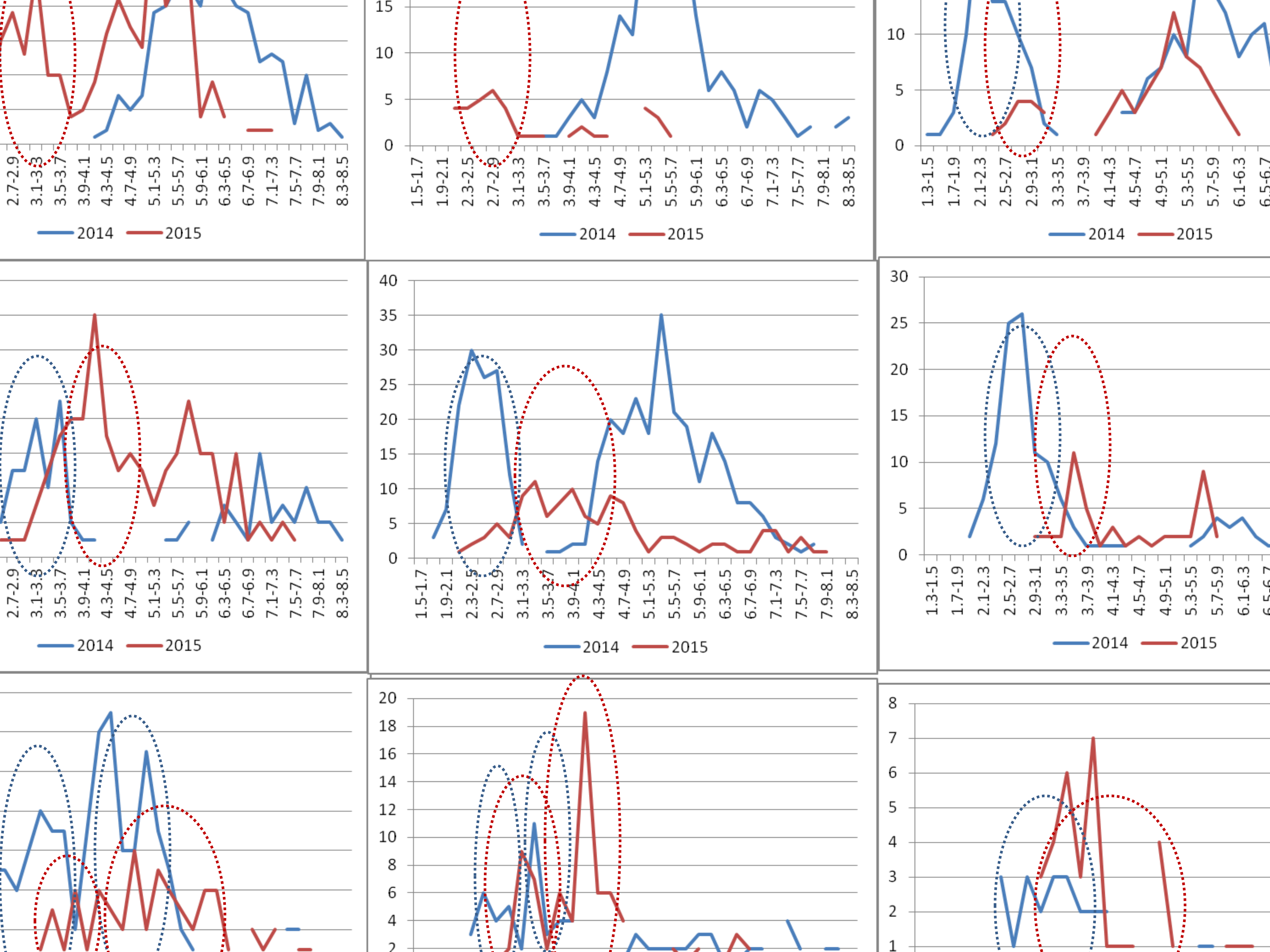
Sampling coverage



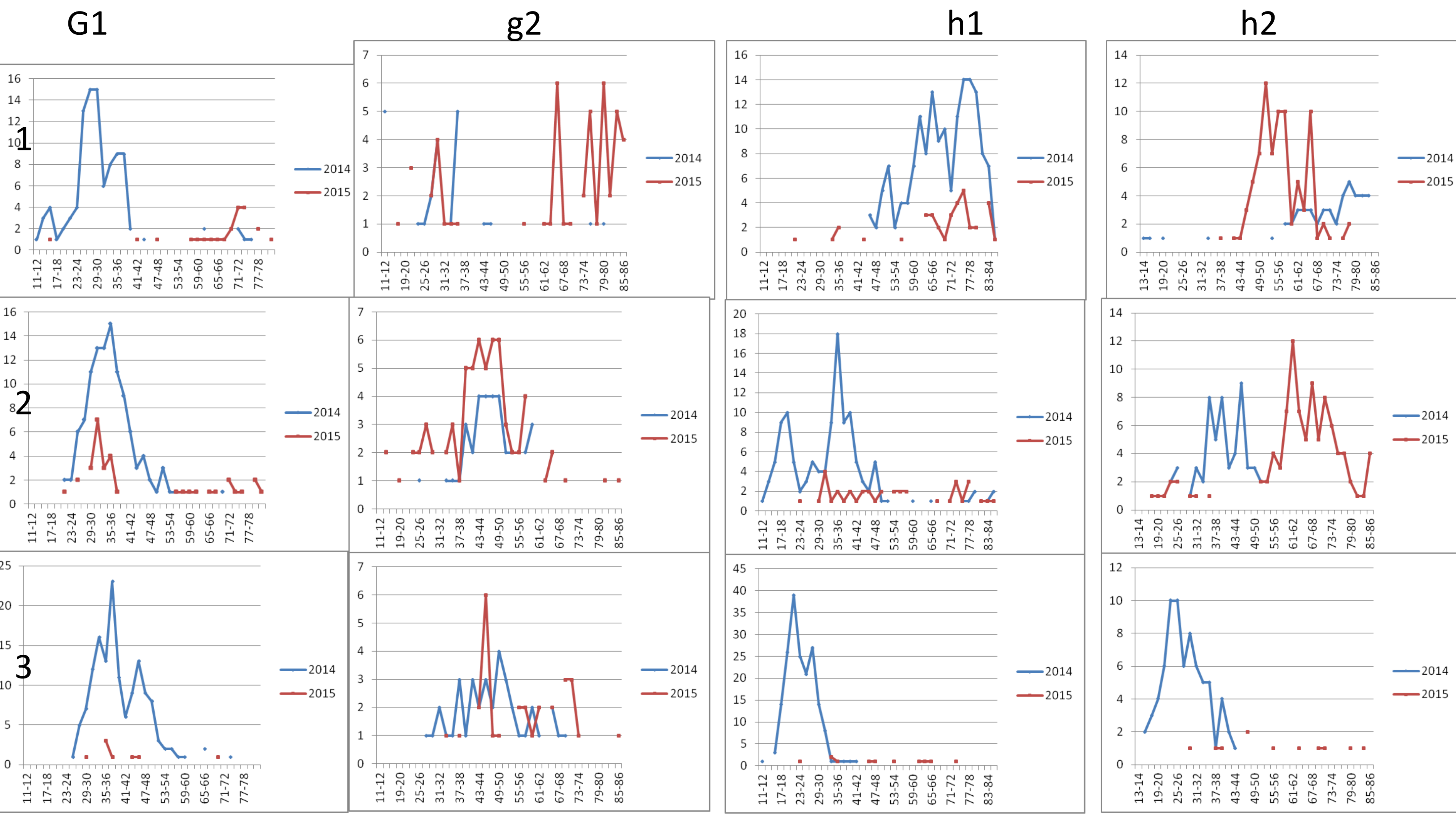
- At three times per year (see below)
  - Mid July,
  - early August
  - late August/early September

Number of 0 group flounder

Transect	Country	2015	2014
A	Finland	0	0
B	Estonia	12	16
C	Latvia	430	643
F	Germany	Few	5
G	Sweden	160	651


2014
2015

Sweden



Annex 3

Baltic cod in INSPIRE

Juvenile cod:

- Intention for INSPIRE: Recruitment index, habitat suitability of nursery areas, validation of drift models
- Status from gillnet surveys and BITS: 2013 and 2014 recruitment failure -> no samples to work on

Eastern Baltic cod in distress

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ICES Journal of Marine Science

ICES CIEM International Council for the Exploration of the Sea / Conseil International pour l'Exploration de la Mer

ICES Journal of Marine Science; doi:10.1093/icesjms/fsv109

Food for Thought

Eastern Baltic cod in distress: biological changes and challenges for stock assessment

Margit Eero[1*], Joakim Hjelm[2], Jane Behrens[1], Kurt Buchmann[3], Massimiliano Cardinale[2], Michele Casini[2], Pavel Gasyukov[4], Noél Holmgren[5], Jan Horbowy[6], Karin Hüssy[1], Eskild Kirkegaard[7], Georgs Kornilovs[8], Uwe Krumme[9], Friedrich W. Köster[1], Rainer Oeberst[9], Maris Plikshs[8], Krzysztof Radtke[6], Tiit Raid[10], Jörn Schmidt[11], Maciej T. Tomczak[12], Morten Vinther[1], Christopher Zimmermann[9], and Marie Storr-Paulsen[1]

Major issues

- Increase in recruitment
- Distribution range
- Decrease in condition
- Length composition
- Seals: Predation and parasites
- Ageing problems

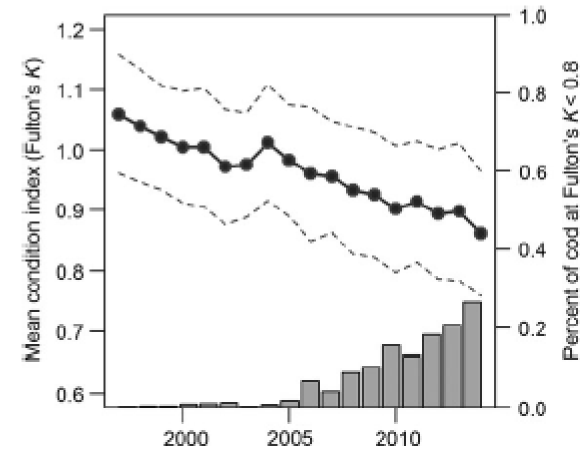


Figure 2. Average condition (Fulton's K) of 40–60 cm cod in Bornholm Basin with the standard deviation (the lines) and the proportion of cod with Fulton's $K < 0.8$ (the bars).

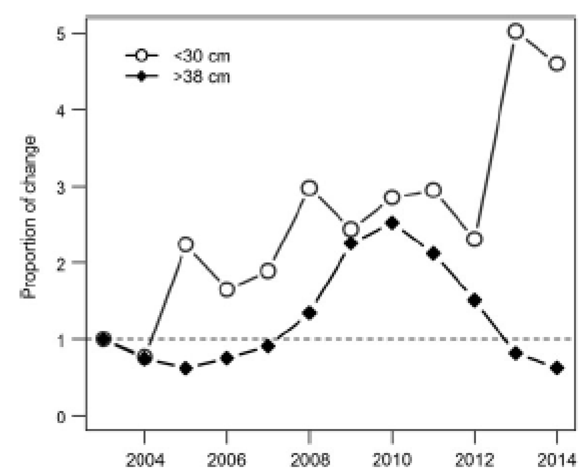


Figure 1. Change in biomass of juvenile (<30 cm) and market-size cod (>38 cm) in 2004–2014 relative to 2003, based on data from International Bottom Trawl Surveys (geometric mean of Q1 and Q4 surveys) in the entire central Baltic Sea.

The biggest problem: AGEING

Review of age estimation in eastern Baltic cod: Problems, explanations and solutions (*submitted to ICES J*)

K. Hüssy[1*], K. Radtke[2], M. Plikshs[3], R. Oeberst[4], T. Baranova[3], U. Krumme[4], R. Sjöberg[5], H. Mosegaard[1]

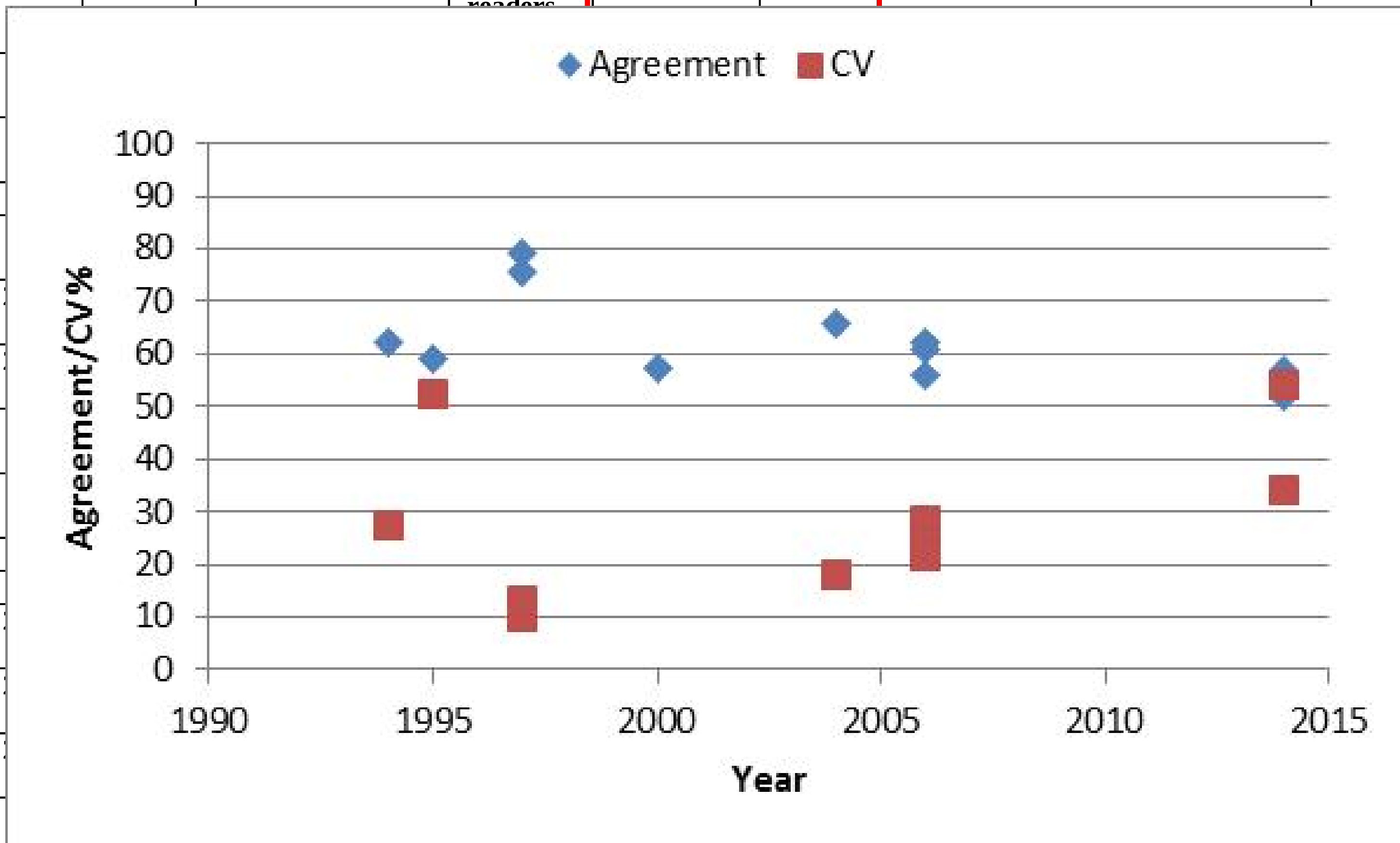
Review of:

- Historic age reading exchanges (1973-2014)
- Alternative ageing methods
- Validation methods
- Biological explanations

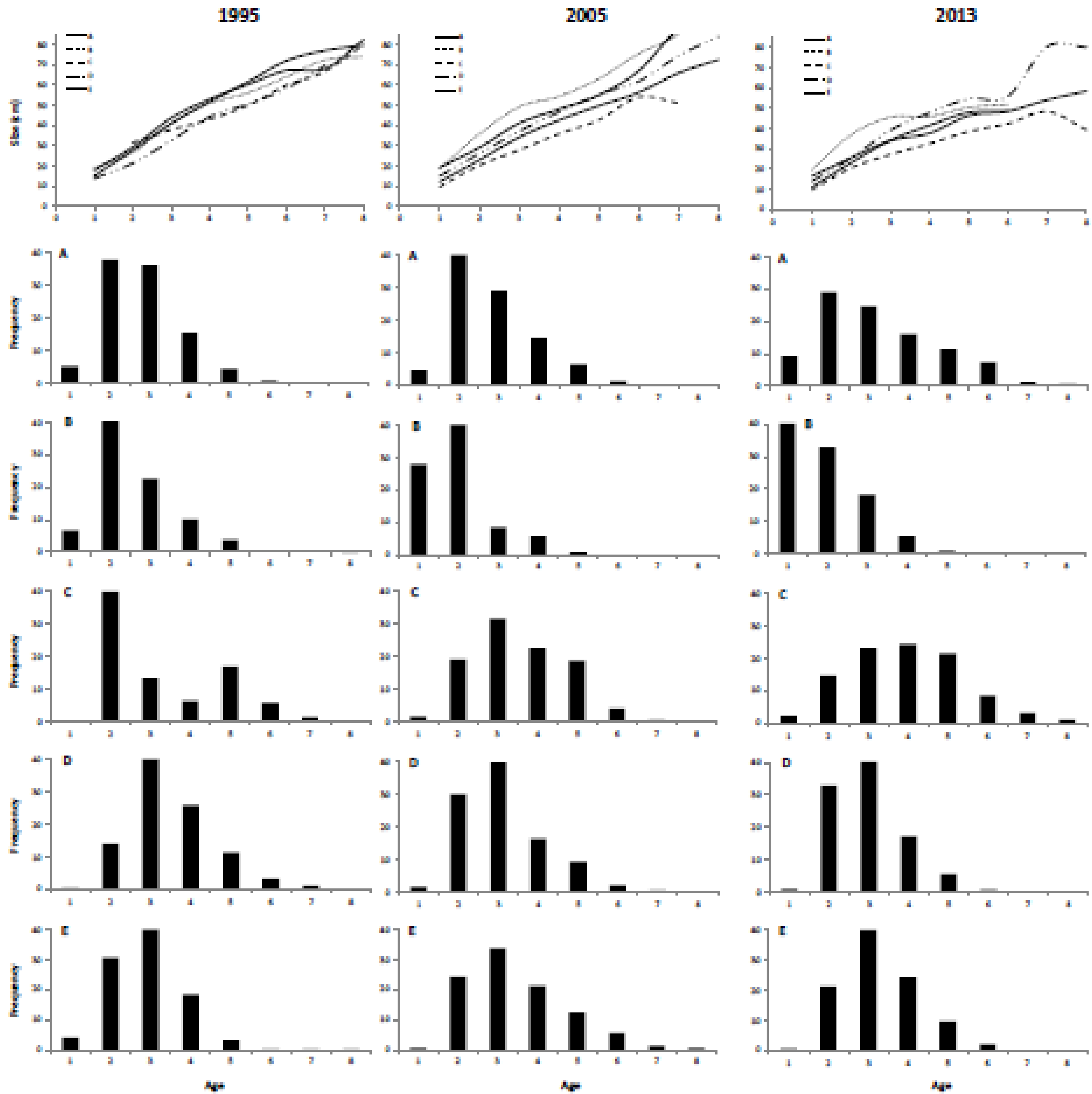
Reccommendations for ”safe” ageing procedure (Campana, 2001):

- Agreement > 80%
- CV < 5 %

Area	Year	Participants	N readers	Agreement	CV	Conclusions	Reference
24							994
24							
24							997
24							
25, 28							973
25,							985
26							994
26							
26							997
28							997
26,							000
25, 28							
24, 26							
25		POL, RUS, SWE				readers, age-related bias pattern	2006
25	2005	DEN, GER,LAT, POL, RUS, SWE	7 (25)	62.1 (62.4) [3]	21.6 (20.9) [3]	Significant difference between readers, age-related bias pattern	ICES, 2006b
25	2014	DEN, GER,LAT, POL, RUS, SWE	7 (200)	52	34	Significant bias between 4 readers. Within reader agreement 50-83% [4] and CV 5.2-16.3 [4]	ICES, 2014b
25	2014	DEN, GER,LAT, POL, RUS, SWE	7 (100)	57 [5]	46-100 [5]	Significant bias in 4 readers compared to true age	ICES, 2014b



Size@age and age distribution



Initiativs for a solution

BalticSea2020 proposal:

- Goal: provide data and methods for length-base assessment

- What:
  - Large scale tagging program
  - Ageing method based on otolith microchemistry
  - Tagging: SWE, POL, GER, DK
    (Non-tagging: budget for advertisment?)