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.

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Executive Summary

The current report provides information on the discussions held and decisions made at the first integrating workshop of INSPIRE. The overall aim of integrating workshops is to ensure timely discussions of important issues of the project to secure achieving the project deliverables. The following major issues were discussed at the meeting:

- *Establishing cooperation and planning activities with other BONUS projects,*
- *Data management by considering various types and formats of data to be collected and assembled,*
- *Review of fieldworks carried out in summer and spring 2014 and discussing any amendments needed in the existing fieldwork guidelines,*
- *Probabilistic modeling of the Baltic Sea ecology,*
- *Linking activities between different workpackages,*
- *Planning concrete activities related to upcoming deliverables.*

It was stated, amongst others, that field works have been successful in 2014, but some amendments to the fieldwork guidelines would be needed. These were identified in details and provided with justifications. Testable hypotheses for analysis of spatial distribution (WP1) were identified and assembled prior to the meeting and discussed at the workshop. In addition, both limitations as well additional avenues for application of modeling approaches were identified and it was agreed to continue those discussions intersessionally.

Introduction

Integrating workshops are seen in INSPIRE as venues to ensure effective and efficient linkage not only across the various workpackages, 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 worshops planned in the project.

Based on the decision of the project Steering Committee, the first integrating workshop was held in conjunction with the ICES Annual Science Conference during 16-17. September 2014. The meeting was co-convened by Michele Casini (SLU) and Christian Möllmann (UH). The meeting was attended physically by 19 participants. In addition Margit Eero (DTU-AQUA) attended the meeting via Skype.

Core activity

The current report is organized by workshop agenda (see Annex 1).

General: welcome, discussion of agenda and discussion on future meetings. BONUS & INSPIRE updates

Henn Ojaveer informed the meeting participants on the outcomes of the BONUS kick-off meeting (held in Riga in August) and follow-up activities taken in INSPIRE.

BONUS encourages cross-project clusters, to create synergies and increase the added value of the research. INSPIRE has identified two projects with which cooperation is mutually beneficial. These are BIO-C3 and BAMBI. The following three actions for cross-project cooperation were already initiated and shortly discussed at the meeting:

i. Submission of the joint Theme Session proposal by INSPIRE, BIO-C3 and BAMBI for the ICES ASC 2015 (to be held in Copenhagen, Denmark).
ii. Arranging joint BIO-C3/BAMBI/INSPIRE summer school in 2015. Although this is not scheduled into INSPIRE workplan, it was suggested that joint summer school is a good idea and allows INSPIRE PhD students to participate in the summer school.
iii. Assembling information on INSPIRE planned field works in 2015 and sharing this information with BIO-C3 and BAMBI.
iv. Initiation of the Baltic zooplankton study jointly with BIO-C3. For INSPIRE, this will be important for investigation clupeids spatial ecology.

1. Database issues (Stefan Neuenfeldt, DTU-AQUA)

<u>Format of survey data</u>

The INSPIRE surveys are timed to act as supplement to the standard Baltic International Trawl Survey (BITS) and to provide data from the shallow water areas not covered by BITS. The focus of the INSPIRE gillnet surveys is on flounder and small cod and will in addition to standard fishery data also provide information of the target species' habitat characteristics for later habitat modelling. The main goals of the data derived from these surveys are i) stock identification of pelagic and demersal flounder, ii) recruitment index of cod, and iii) Quantification of nursery habitat quality of juvenile cod.

The survey consists of 11 transects distributed over the entire Baltic Sea and are fished twice a year in two consecutive years. The transects are managed by different project partners. The survey design is especially tailored to fulfil the tasks for INSPIRE, but resembles as far as possible the HELCOM fishing standards.

Each transect consists of a series of stations at predetermined depth strata. At each depth stratum 5 replicate stations are to be conducted. The exact timing of fishing at the different stations is determined by the project participant responsible for each individual transect and may differ between partners due to the logistic setup of the survey and

The sampling protocol and templates for the data files are detailed in the INSPIRE gillnet survey protocol. Per station, 4 files are foreseen to be collated centrally in the project:

- Catch and environmental data
- Protocol for individual sampling of flounder
- Protocol for individual sampling of cod
- Temperature, salinity and oxygen profiles (this file is not specified explicitly in the sampling protocol, please include pos. lat., pos. long., time, depth and then the environmental data)

The INSPIRE survey data will be collected at DTU Aqua. The data will be kept at DTU Aqua and UT-EMI and will be released to project participants by request. Furthermore, the data will be submitted to ICES Data Center.

Acoustics data

The acoustics data collected during the experimental acoustic surveys will be collected at DTU Aqua with a copy held at UT-EMI. As well as the survey data, the acoustic data will be made available to the project participants on request.

In traditional acoustic sampling the raw data are oftentimes not available, but stored as biomass per spatial unit, oftentimes per ICES rectangle. INSPIRE aims at analyzing small scale structure in clupeid distributions, in order to assess for example school dimensions, and allow for analyses of school formation, also beyond the projects time horizon. For this reason, it has been discussed at the workshop. How these large data volumes are to be stored and transferred. The acoustics data collected during the experimental acoustic surveys will be collected at DTU Aqua with a copy held at UT-EMI. As well as the survey data, the acoustic data will be made available to the project participants on request.

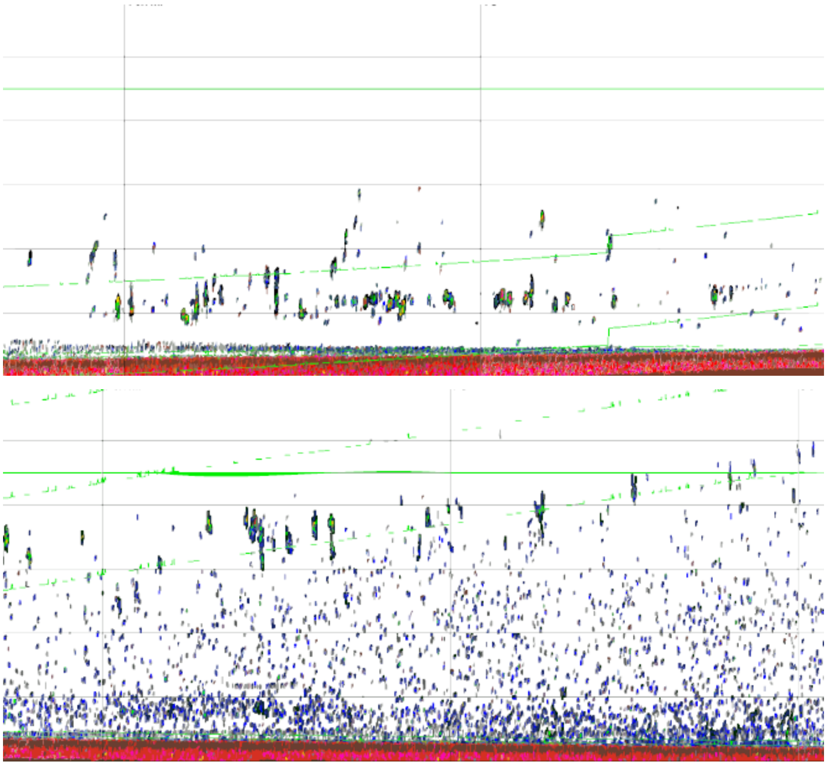

Figure 1.1 Upper and lower panel: school deformation during dusk in the Bornholm Basin of the Baltic Sea. The green line indicates the constant light horizon the fish live in. INSPIRE aim at collecting data which will allow to quantify both school size distribution, distance between schools and so further.

Stomach data

INSPIRE workplan foresees clupeid stomach content analyses. In addition, there have been excessive sampling and analyses during the last couple of years within the frame of an EU data tender, coordinated by DTU Aqua. These stomach data will be made available to INSPIRE project participants on request.

BITS survey data

The BITS survey data are available at ICES. These data are intensively used in INSPIRE in collaboration with ICES within the frame of the ICES Study group of spatial processes in the Baltic Sea, which is chaired by INSPIRE participants from SLU Aqua and DTU Aqua.

Tagging data

Historical tagging data for cod aare currently collected at UHAM and will be put into a database which is going to be stored at DTU Aqua and UT-EMI. The data include all so far computerized cod tagging experiments for the Baltic Sea and will be made available on request. During the workshop, the availability of tagging data for herring and sprat has been discussed.

Data storage

The combined data from all project participants data are stored at DTU Aqua and UT-EMI. DTU Aqua will contact the project participant involved in the INSPIRE survey and experimental acoustic surveys in order to organize the upload of data.

2. Review of cod and flatfish work

2.1 Gillnet surveys (Ann-Britt Florin, SLU and Karin Hüssy, DTU-AQUA)

All 11 transects planned were carried out (Figure 2.1). It was however due to long distances not possible to fish replicates within depth intervals at different sampling days of the survey to minimize depth/sampling date correlation. Each transect consisted of series of stations at predetermined depth strata: 5, 10, 20, 50 & 70m with 5 stations per depth. However due to long distance the deepest strata was not fished in transect B. In transect E & G there were no areas > 20m and in E an additional 5 stations were put at the Oderbank. The offshore transect, I, miss shallow areas, so 5 additional stations were fished at an intermediate depth (Table 2.1).

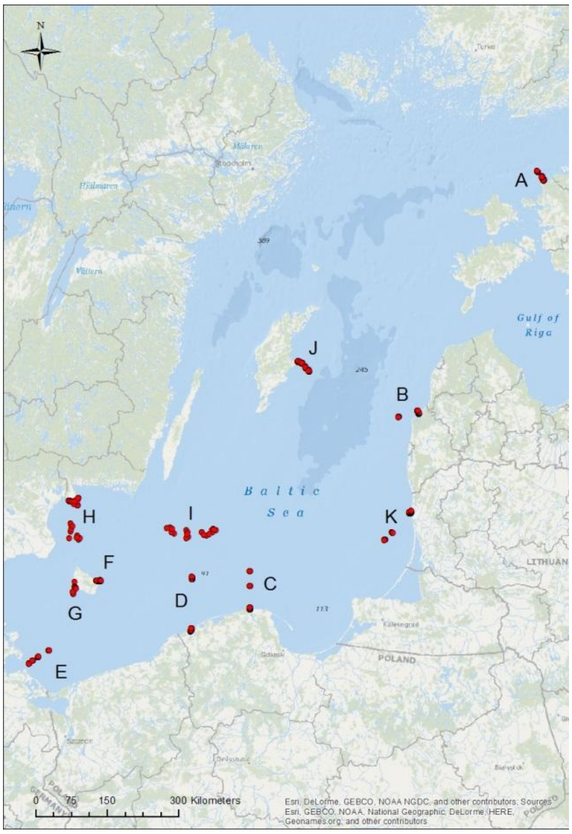

Figure 2.1. Fished gillnet stations in spring 2014.

Table 2.1. Number of fished stations per transect and depth interval.

Transect	5	10	20	50	70	30	Total
A	5	5	5	5	5		25
B	5	5	5	6			21
C	5	5	5	5	5		25
D	5	5	5	5	5		25
E	5	10	5				20
F	5	5	5	5	5		25
G	5	5	5				15
H	4	5	5	6	5		25
I			5	5	5	5	20
J	5	5	5	5	5		25
K	5	5	5	5	5		25

The Nordic coastal multi-mesh gillnets extended with two extra mesh sizes, and strengthened lead line to allow for machine hauling worked well. For stations deeper than 50m a special float line were used. Due to cancelled delivery of nets transect A and E become delayed but with borrowing from other PI's and using ordinary non extra strengthened Nordic Nets on shallow stations in transect E and I all transects were fished within the predetermined time interval April-May. All but one, transect A, was fished using commercial vessels for sampling and all fishing operations worked well.

CTD cast is available for 9 transects, for the other temperature and salinity was recorded manually at depth intervals. According to manual all variables should be recorded at every station. However, recording of environmental parameters were very time consuming and hence some PI:s measured only once or twice per depth strata. In addition there were technical problems with the CTD and camera at some occasions and too bad weather at others to allow for measurements. Assuming values for wind, temperature, salinity and Secchi depth can be extrapolated from nearby stations the only parameters not fulfilling the objectives of the survey plan is oxygen and habitat which is missing from 3 transects due to delayed delivery of equipment.

In total 35 fish species were recorded. The total catch of the target species were 2 564 flounders and 74 small cod (≤20cm). The sparse occurrence of juvenile cod is worrisome but probably more individuals will be caught at the autumn survey and no changes to the planned survey is made.

Sampling of individuals was performed according to the plan; 1530 otoliths and 1010 genetic samples of flounder and otoliths, genetics and stomachs were sampled from all juvenile cod. In addition some samples were also taken for priority 2 species – adult cod and other flatfishes.

Egg (specific gravity) and spermatozoa (mobility at different salinities) characteristics have been assessed for in total 162 individuals to distinguish between the two flounder ecotypes ("pelagic" and "demersal" spawners). Measurements were performed in connection with gillnet surveys at transect H and J, and during a survey with R/V Alkor (GEOMAR) in April 2014.

In conclusion the overall objectives of the gillnet survey have been accomplished. Main problems have been due to late or no delivery of equipment. The sampling scheme was very intense and a revision of the manual simplifying registration and lessening the burden of the field personal is advised for the autumn survey. The catch of juvenile cod was extremely sparse but hopefully the autumn survey which is designed to target cod will cover cod better. All PI's are ready to perform the autumn survey and all equipment, gillnets, cameras and oxygen are now in place.

2.2 Beach seine surveys (Didzis Ustups, BIOR)

Before the sampling season all countries developed and accepted Beach seine manual. According to manual sampling should be performed in three depths (0.2, 0.6 and 1 m) parallel to the coast line. Area of sampling should be at least 120 m^2. Time of sampling was settled from July to middle of September however it could be modify according to local expertise about flounder settling in particular area

All of the planned transects were performed (Figure 2.2). Flounders were extremely sparse in transect B & F which might be due the decided sampling dates missing the settling of flounder in these areas being too early in transect B and too late in transect F (Table 2.2).

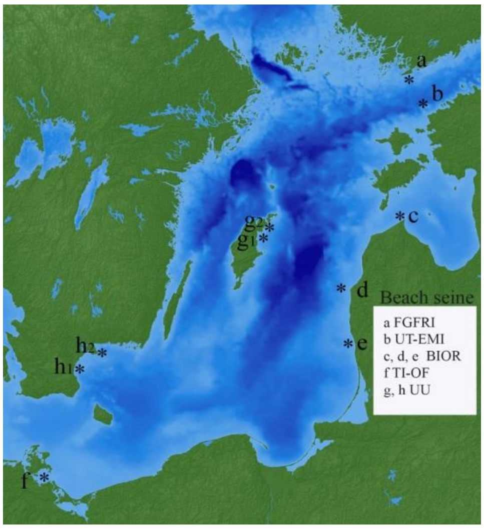

Figure 2.2. Map of the INSPIRE beach seine survey sampling locations. Asterisks and letters identify the locations for the beach seine surveys. The letters in the legends correspond to these locations and identify the institutes responsible for each survey location.

Transect A is part of a long term environmental monitoring and hence it is sampled according to a different manual so results might not be directly comparable to the other INSPIRE Beachseine surveys.

Table 2.2. Time of beach seine surveys by countries. Yellow box indicates 1st survey, green - second survey and red - 3rd survey. Black box shows survey time period according to beach seine manual.

	May				June				July				August					September				October			
Germany										Yellow			Green						Red						
Sweden									Yellow			Green	Green				Red	Red							
Latvia											Yellow			Green			Red	Red							
Estonia											Yellow			Green			Red								
Finland		Yellow	Yellow																				Red	Red	

High abundance of flounder juveniles was detected in transects c, d, e, g and h. All of transects with high abundance were located in the Central Baltic Sea. According to preliminary results from the Central part of the Sea in some areas two peaks in length distribution of 0-group of flounder were detected.

In conclusion the overall objectives of the beach seine survey have been accomplished. The main problems have been due to low flounder abundance in some of the transects. In the meeting possible solutions for the next season were discussed. It was found that otoliths collections from 0 group of flounder is very time consuming. According to Beach seine manual all of otoliths from 0group flounder should be collected for later analyse. Due to available limited funding some countries could not collect otoliths and fish are still preserved in ethanol.

3. Review of clupeids field work (Georgs Kornilovs, BIOR and Tiit Raid, UT-EMI)

3.1 Joint Latvian-Estonian hydro-acoustic survey in May in Sub-divisions 26, 28, 29 and 32

The survey was performed on the base of regular May hydro-acoustic survey of BIOR which usually covers the Latvian economic zone in Sub-divisions 26 and 28. In May 2014 this survey was supplemented by works in Estonian economic zone in Sub-divisions 29 and west part of Sub-division 32 (Figure 3.1). In all area of the survey the conventional hydro-acoustic works were done including acoustic recordings in a route of 925 nautical miles and 31 control hauls. The length measurements were performed for 6284 sprats, 4692 herrings and 642 other fish species. For the age determination 2832 sprat and 2136 herring otoliths were taken.

On the whole area of the survey the ichthyoplankton sampling was performed by vertical hauls and circular hauls in the upper water layer. Altogether 90 vertical and horizontal hauls were performed by IKZ net directed for sprat eggs and larvae. Samples are stored in formalin solution and are analysed in BIOR. Caught sprat larvae are deep-freezed in EMI-UT lab in -86 degrees for further analyses. The first analysis show that the most active sprat spawning took place in the Gotland Basin Sub-divisions 26 and 28. The number of sprat eggs strongly decreased in the direction to north. There were almost no sprat larvae in the northern areas.

45 Juday net mezozooplankton samples were collected from Estonian and Latvian zone. Samples will be processed in BIOR and UT-EMI. CTD measurements were made in each station: temperature, salinity, chl a, turbidity and oxygen concentration (surface>bottom). Data are stored by stations in computer.

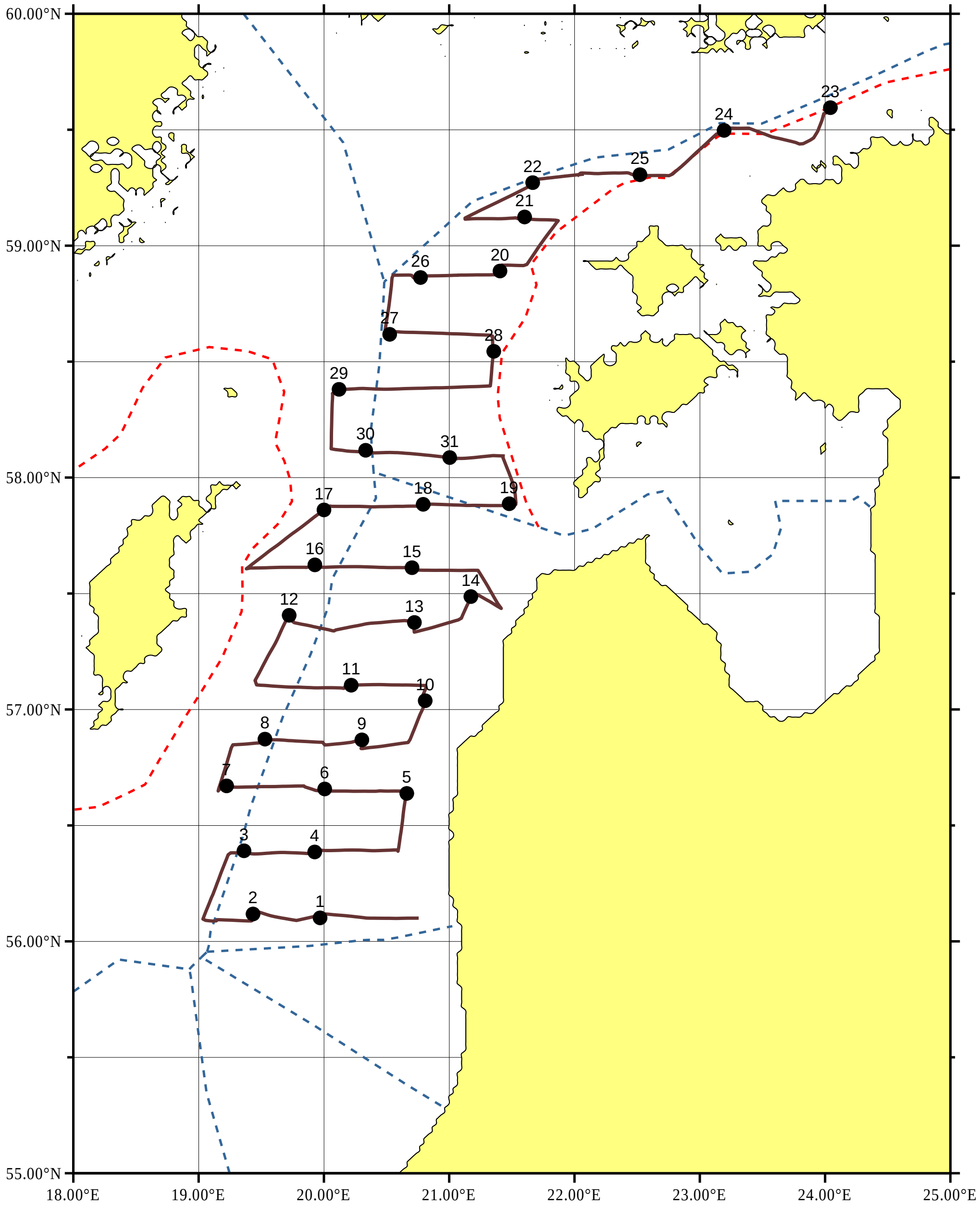

Figure 3.1. Track of the joint Latvian-Estonian hydro-acoustic survey in May.

3.2 Second Latvian-Estonian Ichthyoplankton survey in the Baltic Sea on 15-21 of June 2014

On the whole area of the survey the ichthyoplankton sampling was performed by vertical hauls and circular hauls in the upper water layer. Altogether 127 vertical and horizontal hauls were performed by IKZ net directed for sprat eggs and larvae (Figure 3.2). Samples are stored in formalin solution and will be analysed in BIOR. Caught sprat larvae are deep-freezed in EMI-UT lab in -86 degrees for further analyses. The distribution of sprat eggs and larvae was similar with the May survey. There were much more sprat eggs and larvae in the Latvian economic zone and were rather low in the northern part in Sub-divisions 29 and 32.

39 Juday net mezozooplankton samples were collected from Estonian and Latvian zone. Samples will be processed in BIOR and UT-EMI. CTD measurements were made in each station: temperature, salinity and oxygen contsentration (surface>bottom). Data are stored by stations in computer.

The ichthyoplankton surveys were planned with the aim:

- ✓ to determine the main spawning and nursery grounds for sprat in the north-eastern Baltic Proper;
- ✓ to determine the importance of different areas for the reproduction of sprat: central eastern Baltic, central north-eastern Baltic and western part of the Gulf of Finland.
- ✓ to compare the differences in the growth rate (from larval sprat otoliths), condition (biochemical analyses) and survival of sprat eggs and larvae between different areas.

The methodology of surveys was agreed during the INSPIRE Kick-off meeting in February 2014.

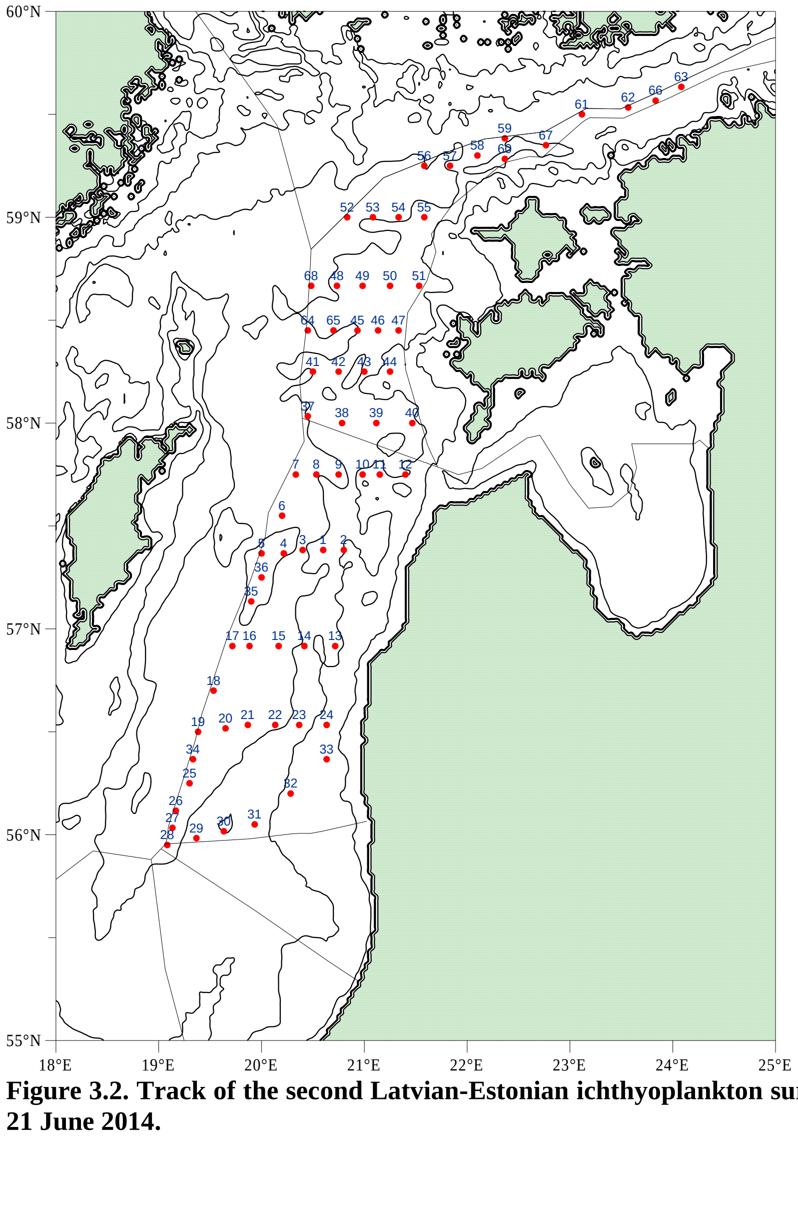

Figure 3.2. Track of the second Latvian-Estonian ichthyoplankton survey in the Baltic Sea in 15-21 June 2014.

3.3 Experimental hydro-acoustic survey in June in Sub-division 28

The experimental hydro-acoustic survey was performed with the aim to improve the methodology of conducting hydro-acoustic surveys in the Baltic Sea. The results of the hydro-acoustic surveys are very important because they are used for tuning the assessments of sprat and herring. The main aims of the given survey were as follows:

- ✓ determination of the influence of the trawling horizon (depth) on the proportion of sprat and herring in the samples;
- ✓ estimation of the influence of the trawling time (daytime or night) on the proportion of sprat and herring in the samples at different depths;
- ✓ collection of material on the vertical distribution of sprat depending on daytime, age and maturation stage.

The survey was partly hampered by very low concentrations of pelagic fishes in the Latvian economic zone. When the vessel managed to find some considerable acoustic records of pelagic fishes the team performed daily station of acoustic observations and recording, and carried out three daily and one night trawling in different water layers. From these hauls the length measurements were made for 704 herrings, 282 sprats and 53 other fish species, and the otoliths were taken from 100 herrings and 86 sprats.

Similar experimental trawlings on different layers of pelagic fish concentrations were also repeated during regular joint Latvian-Estonian hydro-acoustic survey in the Gulf of Riga in July. Due to low concentrations of pelagic fishes in the Latvian economic zone in June it has been decided to carry out such survey in 2015 in September.

4. Analyses of spatial distributions (Michele Casini, SLU)

INSPIRE Work Package 1 focuses on understanding the spatial distribution and habitat preferences of the focus species, cod, flounder, herring and sprat. In order to compile a list of testable hypotheses on the observed changes in spatial distribution, a questionnaire was distributed to the INSPIRE participants two weeks before the 1st Integrated Workshop in A Coruna. The list of asked questions is presented below, along with Table 4.1 below illustrating the results of the questionnaire.

1) What are the main spatial changes of the 4 focus species (cod, herring, sprat, and flounder) during the past decades? I am interested in all resolutions, ex. regional-scale (as all Baltic), small scale (as within a basin), or even finer (coast-offshore), both horizontal and vertical.

2) What are the reasons of these spatial changes, in your opinion (your hypotheses)?

3) Do you, and INSPIRE (ICES databases, previous projects, INSPIRE new sampling), have the data to test these hypotheses?

4) Moreover, what are the consequences of these changes for the species itself (growth, mortality, etc…), and for the other interacting species?

Table 4.1. Summary of the responses obtained from the pre-workshop questionnaire.

Species/ Question	Cod	Sprat	Herring	Flounder
1	-Contraction of the EB cod into the south-western Baltic (Bornholm basin), in late 1980s-early 1990s. -Lack of re-expansion after that. -Emigration of EB cod into SD 24 (mixing with WB cod), since 2007. -This emigration does not contribute to WB cod recruitment.	-Displacement of sprat into the north-eastern Baltic (SDs 28-29 and 32), started in mid 1990s and became very strong in latest few years. -NB: for sprat this is not a new situation -This displacement mostly evident in autumn/winter. In spring sprat migrate more south for spawning, but in latest years also in spring more sprat in the north. -Sprat occur nowadays more in shallower waters.	-Displacement of central Baltic herring into the north-eastern Baltic (SDs 28-29 and 32), long-term trend, not as strong as for sprat. -High abundances in SD 30, low abundances in SD 32 (but ”real” GoF herring are doing pretty well). -What about spawning grounds? Any changes? -No observed spatial changes at the basin level (at least in SD 24).	-Change in distribution during spawning. Decrease in coastal spawners in northern part (demersal spawners). -Around Gotland increased abundance and nowadays in shallower waters and new habitats compared to 10-15 years ago (during feeding). -No info on changes in distribution of pelagic spawners. -Decrease in recruitment/abundance in Gulf of Finland/Åland Sea/Archipelago Sea -Flounder nowadays are leaner around Gotland.
2	-Loss of stock components (reproduction). -Loss of favorable spawning area (reproduction). -Decreased salinity and increased oxygen-poor floors (habitat selection & reproduction). - Decreased stock size (density-	-Reduced mortality by cod in north (survival/active movement). -Increased Temora in north (active movement/larval survival). -Increased spawning in north (reproduction). -Circulation patterns, wind-	-Reduced mortality by cod in north (survival/active movement). -Increased Temora in north (active movement/larval survival). -Increased spawning in north (reproduction). -Nothing about eutrophication	-Reduced salinity in coastal areas (demersal spawners). -Reduced oxygen in deep waters, and salinity (pelagic spawners, bouyancy). -Higher eutrophication in littoral zone. -Changes in

	dependence). -Warning: the 1970s-1980s situation is an exception! -Increased density in SD 25 (density-dependence).	driven (egg/larval drift).	(microphites) etc…?	quality/quantity of Mytilus, increased flounder population. -Oxygen/salinity for distribution outside spawning. -Food (Mytilus, macoma baltica), gobies (competition for mytilus).
3	**EB cod**: -BITS surveys. -Old (1970s-1980s) benthic surveys (BIOR). -Landings. -Tagging database. -Hydrological data. -INSPIRE gillnets surveys. -Tagging (Stefan N. and Christian M. are working on it). -The hypothesis of loss of sub-components not testable at the moment (need of genetic analyses on old samples, not within INSPIRE workplan). **WB cod**: Everything available and some results ready, to be finalysed within INSPIRE (DTU-Aqua).	-Acoustic surveys in autumn and spring (data already available from WGBIFS, plus others in preparation, ex. BIOR). -Cod data. -Hydrological data. -Zooplankton data from BIOR and IFM/GEOMAR (and Henn O. is compiling data from nay stations from another project). -Circulation patterns. -Landings.	-Acoustic surveys in autumn and spring (data already available from WGBIFS, plus others in preparation, ex. BIOR). -Cod data. -Hydrological data -Zooplankton data from BIOR and IFM/GEOMAR (and Henn O. is compiling data from nay stations from another project). -Landings. -In general, to test hypotheses for herring is more difficult, due to uncertainties in stock structure and monitoring of spawning grounds. Important insights will come from WP2 (effect of local larvae abundance on stock recruitment).	- Ichtyoplankton (eggs and larvae), central Baltic from 1970. - BITS Q1, covering only pelagic flounder. -BITS Q4, but covers a mixing of both types. -INSPIRE sampling, to be coupled with previous information. -Tagging from Finland (1975-1989) and Latvia (from 1970s).
4	**EB cod**: effects on sprat and herring	-Decreased predation by cod.	-Decreased predation by cod.	-Changes in connectivity

	mortalities, density-dependent growth in cod and indirectly in sprat and herring. **WB cod**: risk for overexploitation due to the overestimation of stock size.	-Less food availability for cod. -Increased competition in north, with decreased growth/condition both for sprat and herring.	-Less food availability for cod.	between populations can influence quality of management. -Change in condition can increase risk for infestation by parasites. -Larger cod feed on flounder.

5. Review of work related to Transport of eggs and larvae (related Deliverable 2.2) (Andreas Lehmann and Hans-Harald Hinrichsen, GEOMAR)

The INSPIRE research team at GEOMAR Kiel, Germany consists of Klaus Getzlaff (BSIOM modeling support), Katharina Höflich (INSPIRE PhD student, since October 2014), Hans-Harald Hinrichsen (drift modeling, hydrography) and Andreas Lehmann (PI, BSIOM modeling/ drift modeling).

The basic tool/work horse is BSIOM (Kiel Baltic Sea Ice Ocean Model). The model comprises the entire Baltic Sea including the Skagerrak and Kattegat. The horizontal resolution is 2.5 km and in the vertical 60 levels are specified. The variables: 3-d temperature, salinity, oxygen and current fields, 2-d seal level, sea ice thickness and concentration are calculated with a time step of 5 min. Daily averages of these variables are stored in a data bank at GEOMAR Kiel. Two simulations periods have been performed, one with SMHI-forcing from 1970-2010, and the other with ERA-Interim forcing from 1979-2013. The ERA-Interim forcing run will be completed for the years 2014-2017 when the corresponding forcing will be available.

The main activities of the first 7 months of INSPIRE were the preparation of the atmospheric forcing (ERA-Interim) and the execution of first model runs.

Downstream to BSIOM is a Lagrangian drift tracking model. A free amount of individual drifters can be launched at any position within the model grid. Released drifters driven by the model flow field experience the model environment at any time and position. Drifters can be flagged to stop drifting or to be removed, or any other action can be specified.

Different tracking experiments with respect to eggs and larvae of cod and flounder have partly been performed, further experiments will follow. For these experiments, drifters have been/will be released in the model domain in well-known spawning areas for the southern and central Baltic Sea. Their propagation, simulating the advective transport of passively drifting eggs and larvae together with the highly temporally and spatially resolved abiotic environmental conditions along the trajectories have been/will be calculated. Their final destination will be assessed by temporally and spatially resolved distribution and settlement probability maps focused on relative densities of juveniles within different nursery areas.

6. Linking field studies and data analyses to stock assessments work (WP4) (Jan Horbovy, MIR-PIB)

The WP4, Stock Assessments, has two major objectives

1. To include and quantify the effects of migrations and spatial and temporal changes in exploited fish distribution (cod, herring, and sprat) on stock assessments.
2. To provide assessments of the status of flatfish in the Baltic, as a basis for quantitative management of these stocks.

The Work package is organized into 3 tasks:

Task 4.1. Assessment of fish stocks with inclusion of migration, spatial and temporal effects and taking into account impact of cod predation.

Task 4.2. Stock identification of flounder in the Baltic Sea.

Task 4.3. Data analysis and analytical assessment or evaluation of flatfish stocks.

Basic analyses and simulations to be conducted within the tasks are presented below.

<u>Task 4.1</u> Assessment of fish stocks with inclusion of migration, spatial and temporal effects and taking into account impact of cod predation (e.g. spatially disaggregated age-structured methods, models which account for migration, multispecies models).

a) The new knowledge on cod juvenile spatial distribution and habitat specific survival gained in WPs 1-3 will be used to develop recruitment indices for cod.

b) Analysis and quantification of species interactions through predation, using data on observed (and dynamic) overlap between prey and predator.

c) Assessments of herring and sprat by assessment units used by ICES until 1990 and reconfirmed by ICES (in case of herring) as assessment units, will be performed using analytical models.

d) The exchange between western and central Baltic herring (basing on difference in growth rate, morphometric characters, parasites) will be taken into account and assessment model which includes such migrations will be further developed and tested.

<u>Task 4.2</u> Stock identification of flounder in the Baltic Sea

Using a subset of flounders of known spawning type (sampled in WP1 and differentiated by egg and spermatozoa characteristics) as reference material, different techniques will be applied to develop tools for separating demersal and pelagic spawning flounder (e.g. DNA, advanced otolith micro-chemistry, ordinary morphometric).

Task 4.3 Data analysis and analytical assessment or evaluation of flatfish stocks
In this WP variety of approaches depending on availability and quality of the data will be applied. It will include both simple and little data demanding approaches as well as quite complex models, using age structure evaluated with recommended thin section method. The models and analyses will include:

a) simple catch curve analysis, when very limited data are available,
b) surplus production or difference models, including random effects models and/or Bayesian models,
c) length-based assessment models,
d) comprehensive age-structured models.

The data collected in INSPIRE surveys are expected to lead to improvement of assessments and predictions. That may be realized in a few ways, of which most important are listed below.

1) Assessment and prediction approach, models structure.

   The data collected will help to evaluate stock structure of flatfishes and in this way to define unit stocks for flounder to be used in the assessments. In addition, depending on survey results, potential migrations (cod, flatfishes) may be evaluated and considered in the assessments.

2) Biological data for assessment and prediction models.

   The data collected on shallow waters will provide information on biological parameters of cod and flounder (e.g. age, size at age, maturity) from the waters not sampled so far. Thus, such parameters will be considered and possibly updated at the stock level.

3) Data for models/assessments calibration (tuning)

   Survey series will be two short for direct using in tuning of assessment models. However, the data will be evaluated with respect to how they match standard tuning data and preliminary conclusions will be drawn on how the coastal survey results may contribute to tuning data. If such potential contribution is expected to be substantial, it could be suggested to continue coastal survey in future.

4) Data for prediction models

   One of the key parameter/variable in prediction is future recruitment. At present cod and flounder recruitment in assessment and prediction models is included at age 2 - 3, i.e. age which is covered by BITS surveys. INSPIRE survey on shallow waters will provide information on amount an distribution of young fish, which will be analysed and attempted to use such information/data for prediction of recruitment to exploited stock.

7. Additional agenda item: Probabilistic modeling of the Baltic Sea ecology (related to WP5) (Stuart Kininmonth, SU)

The Baltic Sea is a complex mix of environmental, geomorphological and social factors influencing the ecology of semi-enclosed system. Despite the low species diversity, the high levels of productivity, combined with the delivery of important ecosystem services, demand the careful multifaceted approach to management. The predictive capacity of modeling is harnessed to help inform management decisions about fisheries regulation and nutrient inflows. However the models tend to be based on a tension between realistic complexity and generalist simplicity. Complicated models tend to have been built on an extensive range of deterministic relationships and the elaborate suite of associated parameters. Incorporating stochasticity is a primary requirement for modeling complex systems. Combing this variability with interactions across multiple spatial and temporal scales is required to produce predictions. Here the computational statistics approach of Bayesian Belief Networks (BBN) can provide some assistance for Baltic Sea ecology.

Developing deterministic models across the steep gradient of deep water and coastal environments throughout a fluctuating yearly seasonal cycle is particularly difficult. Confidence in parameterization is often distressingly poor except for the most well studied regions. Bayesian approaches help significantly here in that they provide an accepted way to handle missing data, enable the incorporation of different data types and integrate rapidly with decision tools used by management. In particular the BBN models are a useful mix of expert opinion and collected data such that predictive confidence in the correlations between factors can be developed over time.

For the Baltic Sea there has been significant research done in understanding the dynamics across the established regime shift over the last 100 years. However few studies have begun to explore the spatial heterogeneity of the key processes. In this project with INSPIRE, the emphasis will be to develop more sophisticated models that help explore the spatial relationships. Using a similar set of collected and modeled environmental and ecological data (describing the trophic structure and environmental status) we will develop 2 model approaches in synchrony. The mechanistic model based on essentially describing the relationships and how they interact has been described elsewhere. Here I propose the development of a spatially explicit BBN.

So what exactly is a BBN? This modeling approach is a graphical representation of the probabilities describing two or more events. Quite simply the model structure contains the mathematics to describe the likelihood that one event will occur given some knowledge of another event. Expert opinion is required to ensure the two events are sensibly linked and not just coincidence. Expanding the number of events to fully describe a complex system is possible but often not required and almost certainly becomes awkward in the implementation. So the key is to be selective in the factors that are important and then to use survey or modeled data to generate probability values for the range of observed values across the factors. Using a graphic approach allows key linkages to be used to narrow the focus to the significant correlation pathways.

For the Baltic Sea INSPIRE project, the first step is the collection of data spanning many years and relevant to a suite of factors deemed most influential in the dynamics. The data needs to be spatially explicit and with clear descriptions of the way it was observed or derived from models. This data set is the basis for generating how the model will be developed. In all likelihood there will be multiple models created to ensure that bias in this expert elicited process is minimized.

The next step will be the use of data to generate conditional probabilities such that a fully working model is constructed. This model will encompass spatial structure, not through isolated instances of the model but through a process of identifying the key generic drivers of the spatial location. Specific interaction elements will be introduced, mainly through the use of oceanographic models. Expert opinion will be used to ‘fill’ the gaps in field data. Predictions will be evaluated against independent data and inferences made on future scenarios. The BBN is exceptionally robust at providing a level of how confident the predictions are and where the ‘weak links’ are in the input data. An early version of this BBN is shown in figure 1 but this will alter significantly following the data assembling phase and expert review.

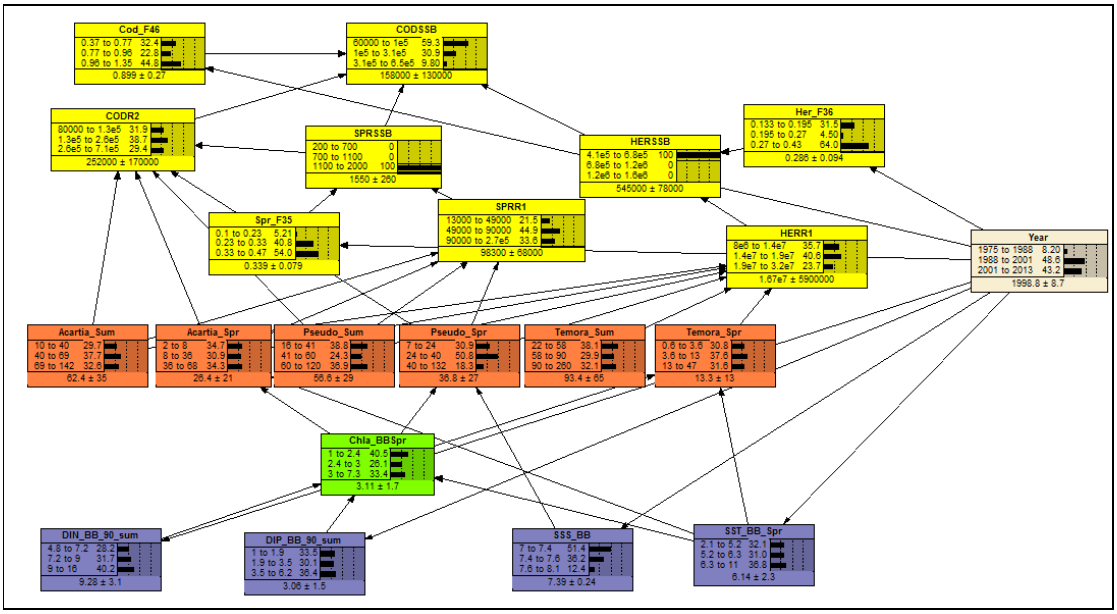

Figure 7.1. Early draft of Baltic Sea BNN with trophic interactions (yellow, orange and green) and environmental drivers (purple) across a 40 year dataset.

8. Planning of next day group work.

Based on the outcomes of the presentations, issues rised, and ensure maximum efficiency of the work, it was decided to organise 3 sub-group discussions on 17. September in the following manner:

1. Sub-groups on ‘Clupeids’ and ‘Cod and flatfish’ will meet during 9:00-11:00
2. Sub-group on ‘Modelling’ will during 11:00-13:00.

8.1. Report of the 'Clupeids subgroup' work (Tiit Raid, Georgs Kornilovs and Patrick Polte)

The sub-group discussed several issues connected to the practical steps of studies of clupeids within the framework of the BONUS/INSPIRE project. Below presents a summary of the discussions.

<u>1. Upscaling from individuals to populations (WP3)</u>
Mechanisms affecting early life stage mortality and thereby recruitment success of fishery species in the Baltic Sea are considered to manifest on various spatial scales. For species with pelagic eggs, such as cod, flounder and sprat, hydrodynamic distribution mechanisms are crucial for survival. Those oceanographic drivers of fish recruitment will be successfully investigated by hydrodynamic modelling as part of INSPIRE.

However, herring in the Baltic Sea to a large extent spawns adherent, demersal eggs attached to benthic substrates in the littoral zone of inner coastal waters (i.e. bays, lagoons and estuaries). Hatching larvae often are aggregated in those sheltered water bodies using those as retention areas throughout their early ontogenesis. At the same time, it is not entirely understood at what development stage and how they eventually leave these coastal systems.

Since the inshore spawning grounds for several Baltic herring stocks are regional, managed by single nations, the understanding of the contribution of those spawning areas/stocks to the overall Central Baltic Herring stock dynamics is essential to avoid effects of potential regional mis-management on an internationally used resource. For herring local hazards on spawning grounds and retention areas might well affect the entire recruitment of a certain stock. In WP3 we aim understanding of those local mechanisms for all of the species in focus and try to follow up on the effects on their transition to the level of adult populations. Due to the above named ecological traits this might be particularly important for a sustainable use of herring in the Baltic. However within WP3 it is a crucial question if and how monitoring of local basin-scale events in recruitment process of Baltic herring can be used as a potential assessment tool ; why some of those have been successful, but the others not.

Field work on herring ecology - ongoing and planned:
TI-OF (Patrick Polte) informed the group on the following ongoing field studies:

i. **Amendment to the Rügen larval herring survey in Greifswald Bay: Sampling of later larval stages:** In the framework of the annual monitoring of herring larvae abundance in Greifswald Bay, Germany (EU Data Collection Framework) a recruitment index is calculated every year to estimate reproduction success of Western Baltic spring spawning herring. This index assumes that from a larval total length of 20mm the majority of variability in larval mortality is over and finally the amount of those larvae correlate well with the1-and 2 year old juveniles in the Western Baltic Sea as investigated by the German hydro-acoustic surveys. Since hydrodynamic models indicate that larvae widely remain in Greiwswald Bay until that size class is reached it is not known at what stage they actually leave the Bay. Since the index derived in Greifswald Bay is the only assessment tool currently used for the 0-group of Western Baltic spring spawning herring, local drivers and stressors for early life stage mortality in this basin actually affect management of the entire stock. As part of INPIRE the TI-OF started in February 2014 to add ship time to the weekly Rügen larval herring survey to fish with a Ringtrawl (CALCOFI, 1m diameter ,mesh size 1500µm) for older larval stages (post-flexion >20mm). Sampling included 16 weeks from February to March on 6 stations along a transect from inshore to offshore. Data processing is ongoing but first results are expected in winter 2014/2015. This program is going to be continued over the season 2015.

ii. **Studies of local hazards for herring egg development:** To gain understanding of local hazards on egg development, TI-OF installed three transects in Greifswald Bay parallel to the shoreline at well-known spawning grounds. These transects cover 3 different depth strata on herring spawning beds in the littoral zone. Every week 6 samples are taken on each transect including benthic vegetation with eggs attached taken by a small van Veen grab sampler. Eggs are taken to the Laboratory, their number and condition is quantified and set in relation to the physico-chemical environment and biotic habitat parameters (e.g. plant composition, epiphytes etc.). Weekly sampling as well as laboratory sample processing is ongoing over most of 2015. However, first results on potential storm effects and distribution of spawning activity along the entire spawning season are to be expected in winter 2014/2015.

EMI-UT (Henn Ojaveer) informed the group that the long-term information on larval herring abundance in the Pärnu Bay (since the 1950s) has been recently uploaded to the ICES databases and so made available to the science community. EMI-UT continues the specific investigations, focused on growth and mortality of larvae in the North-Western Gulf of Riga – on spawning grounds of both spring and autumn herring. Additionally, EMI-UT is in the concluding phase of the study of modelling of suitable areas foe herring spawning along all the Estonian coastline. The results, though preliminary will be available for INSPIRE.

Henn Ojaveer briefed the group on the ongoing in INSPIRE larval sprat studies in with the aim to compare the condition (from biochemical analyses) and growth rate (from larval otoliths) of larvae between different areas. The study was performed together with BIOR in May and June 2014 and will be repeated in 2015.

BIOR (Georgs Kornilovs) gave an overview of available larval and spawning ground data from the Gulf of Riga BIOR also informed the group about the experimental hydroacoustic surveys on chartered Latvian vessel carried out by BIOR in the area with stable concentrations of pelagic fishes in June and July 2014 and 2015 aimed to study the mechanisms of schooling of herring and sprat.

The general discussion on item came to the conclusion that the local specifics of recruitment processes of the Baltic herring are of great scientific value in understanding the spatial pattern of herring stock dynamics. It was proposed that within INSPIRE we should consider the producing a paper summarizing the respective information available. Since the status of local natural populations of the CBH is largely uncertain, it was realised that we should focus on a few distinct gulf herring populations (Bothnian Sea, Gulf of Riga and Gulf of Finland) . The paper should focus on the comparative analysis of the whole recruitment process from the spawning grounds to adult stock dynamics. The population specific recruitment model would be one of the goals. The group also recommended that it would be necessary to get the respective input also from the southern part of the sea (e. Vistula bay herring).

Tiit Raid was tasked to pick up the contact with Finland (Eero Aro) to get Finnish input for the Gulf of Finland and Bothnian Sea. The work is strongly connected with the another task discussed during the sub-group meeting- compilation of knowledge overview on the Baltic herring (see below).

The work would have a strong link to the WP 4 (Assessments).

2. Review on the Baltic herring ecology

A lot of knowledge on herring ecology has been accumulated along Baltic Sea shores over the decades concerning the different stocks. However, many studies were published in the particular national languages or in Russian during the Soviet regime respectively. Hence they are not available to the scientific community as a whole. Also, a lot of paradigms are transported into common sense although their primary sources are somewhat difficult to track. To identify crucial research gaps and to receive an overview on the current state of knowledge the INSPIRE group agreed to (re-) review literature on herring ecology related to important mechanisms structuring recruitment success. Instead of a mere collection of published knowledge a more applied concept was created assigning publications to certain ontogenetic stages along the herring life cycle and relating the basic findings to global paradigms of herring recruitment. As an example: It is widely acknowledged that the larval stage on the transition from yolk sac consumption to first active feeding is a critical period where a major recruitment bottleneck is located. For Western Baltic herring this is the case for early larval cohorts (March) but the later (April) cohorts are rather subjected to egg mortality bottlenecks than stressors to larval feeding. To evaluate these patterns for other local herring stocks along the Baltic Sea might significantly increase our understanding on the drivers of recruitment and effects of environmental alteration.
The baseline for the review process is set by an initial amount of about 300 publications (global knowledge) that will be assigned to different herring life stages in until December 2014. Then, INSPIRE partners will be requested to fill in summaries of their most important, national publications according to one particular herring life stage and then for other life stages consecutively. This effort is considered to be inclusive and open for all experts along the Baltic Sea that are willing to contribute. However the outcome is considered to be highly beneficial to the research aims in INSPIRE, for European fishery assessment and far beyond.

Patrick Polte will take the lead in the initial part of the process.

Tiit Raid was tasked to contact Finland (R. Parmanne) and Russia (A.Petchenko, I. Karpushevski) to inform about the need to participate in the process.

3. Mesoscale events in the clupeids

Stefan Neuenfeldt presented the ideas to take the use of available acoustic raw data in the national labs to study the mesoscale pelagic fish distribution pattern (to translate the acoustic tracks into the fish). BIOR (G. Kornilovs) agreed to send the respective dataset to Stefan to start the trial process.

8.2. Report of the 'Cod and flatfish subgroup' work (Ann-Britt Florin and Didzis Ustups)

Some changes and clarifications to the survey manuals were discussed and consensus was made at all points.

1. ***Skip registration on mesh size for individual samples?***

It is time consuming but mesh size might induce a bias on condition since fatter fish possibly are caught in larger mesh sizes therefore it might be important to record this factor.
Decision: Registration should be kept at mesh size also for individual samplings until the data from surveys have been used to evaluate if mesh size have an effect on condition.

2. ***Length measurements could either all be cm or mm (today mm for individual measurements and cm for catch registration)?***

Registration in mm is not necessary but whole cm is too large for the small cod; using semi cm, i.e. 0.5cm scale is a possibility. However most PI:s did not experience current practice a problem and using semi- cm was not believed to simplify things since most PI:s are not used to this.
Decision: Keep the original manual.

3. ***Reduce flounder parameters***
    a. Skip all flounder individual sampling in autumn survey i.e otoliths, DNA and individual length/weight or maturity is only collected at spring =spawning time.; hence data should
    b. Is it necessary to weigh gutted flounder?

Autumn survey is only shallow stations so we do not cover all flounder distribution therefore flounder could either be reduced to priority 2 species or individual measurement skipped all together. It was however deemed a pity not to sample data when we have the opportunity and it was questioned if there really is any time saving if we expect few flounder in autumn. The rationale for weighing gutted flounder is for estimate of condition.
Decision: Individual parameters of flounders should be taken also at autumn. However to reduce the sampling effort – the sex specific sampling of otoliths is skipped; and gutted weight is used instead of somatic weight (i.e remove guts but let the gonads stay – please leave gonads inside males; keep also the kidney inside the fish)

4. ***Use same or different stations?***

Using different stations for the different surveys would be valuable for habitat modelling however this would make it impossible to disentangle year effect from habitat effect.
Decision: Keep same stations for all 4 surveys

5. ***Reduce number of parameters to record?***
    a. Skip CTD/temp salinity oxygen measurement in closely located stations; assume same profile in nearby station?

b. Skip wind dir/strength in closely located stations; assume same conditions in nearby station?
c. Skip habitat filming in closely located stations; assume same profile in nearby station?
d. Habitat filming only once per year?

Recording environmental parameters is time consuming and it might be very little difference between some stations. However in order for understanding fine-scaled habitat effects we need specific data for all stations.
Decision: Keep the manual recommendation to register all parameters for all stations. Use the data available from surveys too evaluate if some variables might be pooled for nearby stations otherwise collect data by stations. Additional instruction in the manual to check camera at night to see if more filming is needed in the morning.

6. What to do with fish that fell out of the net?

Sometimes fish fall out of the net and you do not know from which mesh size it came; should this fish be discarded, or should you depending on fish size try to allocate it to mesh size or should you record is as mesh size X?
Decision: Fish that fell out of nets should be recorded as mesh size "unknown".

7. What to do when a cod twists the net?

Sometimes a large fish, like cod, might twist the ne and thereby impair the catching efficiency of the nets.
Decision: Note as disturbance in field protocol. Same is true for very large number of the round goby weighing the net down. Anything that seriously affect the efficiency of the gear should be noted in the field protocol.

8. What to do with collected otoliths?

Lots of otoliths have been sampled but it is unclear which of these that should be used for age reading, shape analysis or otolith chemistry and who shall do the age reading. Ti-OF PI from the herring recruitment working group do not have equipment or expertise for flounder age reading and have to explore possibilities of sampling processing. MIR has already read their otoliths. Some kind of exchange of otoliths would be good for quality insurance. Since cod otoliths are few they might be best all read by the same PI.
Decision: Cod & Flatfish champions have a discussion with the otolith chemistry experts for decision on which otoliths should be age read one possible solution is to use asymmetric otolith for age reading and save the symmetric otoliths for later otolith chemistry analyses. SLU offers to help Ti-OF with age reading of flounders otherwise all PI's are expected to read otoliths collected within the surveys they perform in INSPIRE.

9. What to do about turbidity analyses?

Water samples have been taken at the beach seine survey for turbidity analyses but none of PI have equipment for this.
Decision: Everybody have to solve this nationally.

10. Possibility to collect water samples for chemistry analyses in conjunction with surveys – question from Karin Limburg.

Decision: Fish champions to check how this would be used in the INSPIRE project and how much effort would be needed for this sampling and give later instructions to PI before autumn survey.

11. Change registration of temperature for beachseine to per depth?

Experience from current survey showed a large temperature differences between the depths fished.
Decision: Temperature should be recorded by depth.

12. How to subsampling beachseine when catch is large?

Decision: Manual needs to be clarified that first subsample then divide to species and last length measure.

8.3. Report of the 'Modelling subgroup' (Andreas Lehmann, Hans-Harald Hinrichsen, Thorsten Blenckner and Stuart Kininmonth)

BSIOM modeling

During the meeting, the Kiel Baltic Sea Ice Ocean Model (BSIOM) was shortly introduced. The model comprises the entire Baltic Sea including the Skagerrak and Kattegat. The horizontal resolution is 2.5 km and in the vertical 60 levels are specified. The variables: 3-d temperature, salinity, oxygen and current fields, 2-d seal level, sea ice thickness and concentration are calculated with a time step of 5 min. Daily averages of these variables are stored in a data bank at GEOMAR Kiel. Two simulations periods have been performed, one with SMHI-forcing from 1970-2010, and the other with ERA-Interim forcing from 1979-2013. The ERA-Interim forcing run will be completed for the years 2014-2017 when the corresponding forcing will be available.

Daily averaged model output is available for further analysis within INSPIRE. Model output comprises the hydrography including oxygen, currents, sea ice and sea levels of the entire Baltic Sea on a 2.5 km-resolution grid. Further, the atmospheric forcing used for model simulations is available on the BSIOM model grid. Model data can be used for further studies such as on climate variability, calculation of reproductive volumes, habitats, or to integrate/analyze hydrographic measurements taken during research cruises into/with the 4-dimensional model data set. Model data can also be used as forcing/input for other modeling approaches.

Downstream to BSIOM is a Lagrangian drift tracking model. A free amount of individual drifters can be launched at any position within the model grid. Released drifters driven by the model flow field experience the model environment at any time and position. Drifters can be flagged to stop drifting or to be removed, or any other action can be specified.

Bayesian Belief Network

The physical-oxygen model from GEOMAR will provide temporal and spatial data on physical variables (such as temperature, salinity and oxygen in different depths). These data will then be used as forcing variables for the BBN. It has further been discussed that the focus modeling area is the ICES sub-divisions 25, 26 and 28.

Stefan Neuenfeldt reported that the data from his SMS model results as well as fish stomach data are available for the ecosystem modeling.

Stuart Kininmonth presented the BBN approach for the Gotland basin in more detail. The BBN is based on the species interaction matrix and the conditional probabilities are developed from empirical data. Essentially a wide range of data describing the status of the system can be used to develop an understanding of the conditional probabilities. Missing data etc. can be incorporated in the learning stage by a variety of algorithms such as Maximum Likelihood. The main benefit is the neat parameter estimation at a minor loss of network structure. Key feedbacks (loops or cycles) can be incorporated in to the model design through discrete time slices. Tipping points and critical transitions can be scrutinized as variation of the predicted probabilities. The model can then be used to examine the inference and prediction from the marginal probabilities. While the model is still being developed the principal phase for this project is the evaluation and collection of the spatial and temporal data relevant to the Baltic Sea ecology. Expert opinion will then be used to guide the model design with particular relevance to the spatial dependencies.

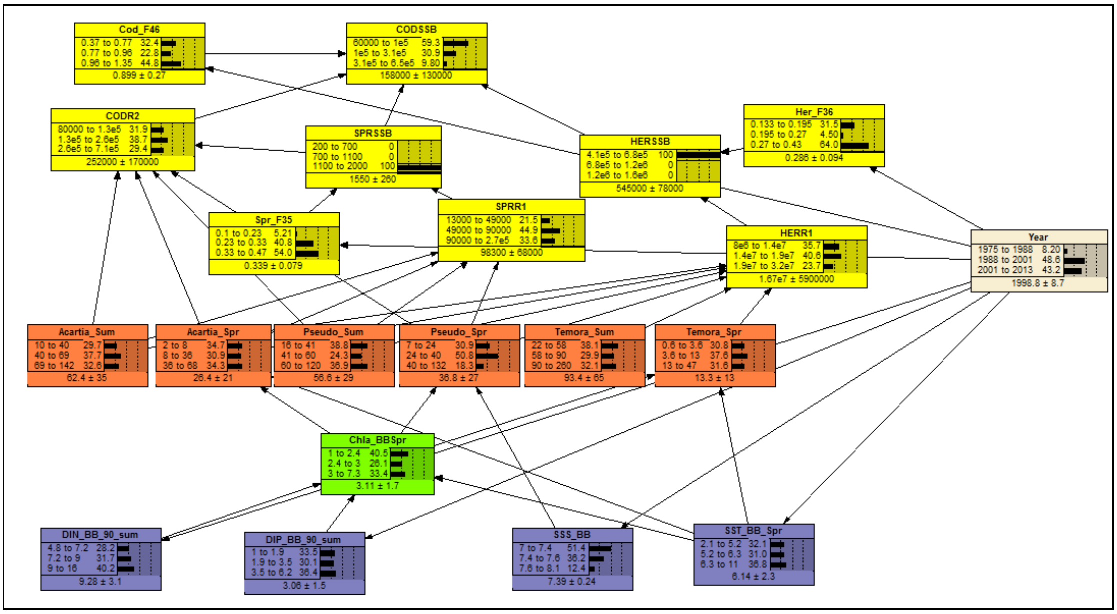

Figure 8.3.1. The draft BBN based on the ICES data.

Annex 1. Meeting agenda.

First INSPIRE Integrating Workshop
A Coruna (Spain); 16–17 September 2014

Meeting place
Hotel NH Atlantico , Jardines Méndez Núñez. 15006 A Coruña (Spain), Meeting Room La Coruna
http://www.nh-hoteles.es/nh/es/hoteles/espana/a-coruna/nh-atlantico.html

Agenda
16 September

09:00-10:00 Welcome, discussion of agenda & discussion on future meetings (especially in relation to ICES). BONUS & INSPIRE updates. *Lead: Henn*

10:00-13:00

1) Database issues (related to Deliverables 1.1 and 2.1). *Lead: Stefan*
    - format of survey data
    - acoustics data
    - stomach data
    - BITS survey data
    - migration data herring sprat
    - data storage
    - time-lines

2) Review of cod and flatfish field work. *Lead: Ann-Britt and Karin H.*
3) Review of clupeids field work. *Lead: Georgs and Tiit*

13:00 – 14:00 LUNCH

14:00-17:00

4) Analyses of spatial distributions. *Lead: Michele*
    - develop hypotheses for distribution analyses
    - static distribution analyses vs dynamic distribution analyses

5) Review of work related to *Transport of eggs and larvae* (related Deliverable 2.2). *Lead: Christian*

6) Linking field studies and data analyses to stock assessment work (WP4). *Lead: Jan*

7) Planning of next days group work

17 September
09:00-13:00

Work in sub-groups on topics and membership as agreed on 16. October (meeting venue to be decided)

13:00 – 14:00 LUNCH (WP leads, fish champions and advisory board) TBC

Annex 2. Participants list

	Name	Partner
1	Henn Ojaveer	UT-EMI
2	Tiit Raid	UT-EMI
3	Christian Möllmann	UHAM
4	Klas Ove Möller	UHAM
5	Georgs Kornilovs	BIOR
6	Didzis Ustups	BIOR
7	Michele Casini	SLU
8	Stefan Neuenfeldt	DTU-AQUA
9	Ann-Britt Florin	SLU
10	Alessandro Orio	SLU
11	Andreas Lehmann	GEOMAR
12	Hans-Harald Hinrichsen	GEOMAR
13	Ania Luzeńczyk	MIR-PIB
14	Jan Horbowy	MIR-PIB
15	Krzysztof Radtke	MIR-PIB
16	Dorothee Moll	TI-OF
17	Patrick Polte	TI-OF
18	Thorsten Blenckner	SU
19	Stuart Kininmonth	SU
20	Eero Aro	FGFRI