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

Project partners:

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1. Executive summary

WP1 on **Spatial Distributions** has finished data collection during the second year of the project. The ichthyoplankton surveys revealed important spawning areas for sprat. Flounder ecotypes studies showed that the sampling in 2015 confirmed the findings of 2014 that both flounder ecotypes (coastal- and deep sea spawners) occurred in ICES Subdivisions (SD) 25 and 28, and that spawning individuals of the coastal spawning ecotype occurred also at 65-80 m depth in SD 28 suggesting that population mixing with hybridisation may occur. Spatio-temporal analyses of cod distribution from pelagic and bottom-trawl surveys evidenced the diel vertical migration at the population level and the importance of density-dependence in adult cod distribution. A Bayesian network model indicated that habitat type plays a very important role in cod distribution but that the interplay to other environmental conditions is non-stationary in a temporal and spatial context. Studies on feeding ecology of Gulf of Riga herring showed that the entrance of the Gulf is the area worst feeding conditions as evidenced by the highest values of empty stomachs and lower values of feeding intensity.

WP2 on **Passive movements, active migrations, and habitat connectivity** utililzed a hydrodynamic model combined with a Lagrangian particle tracking technique to provide long-term knowledge of environmentally-related survival probability and drift of eastern Baltic cod eggs and yolk-sac larvae. Population connectivity of eastern Baltic cod eggs and yolk-sac larvae between the different spawning grounds was estimated. Egg buoyancy in relation to topographic features like bottom sills and strong bottom slopes could appear as a barrier for the transport of Baltic cod eggs and could potentially limit the connectivity of Baltic cod early life stages between the different basins in the central and eastern Baltic Sea. The spatio-temporal dynamics of stock mixing were analysed using shape analysis of archived otolith, and the impact of “Eastern” cod’s immigration on recruitment by hydrographic drift modelling. The percentage of “Eastern” Baltic cod in the Arkona Basin increased from ca. 20 % before 2005 to > 60 % in recent years. On the other hand, for longer distances than between adjacent basins, tag-recapture data-points indicate that cod in general do not perform long-distance migrations, but that only a small fraction (<10%) of the tagged population is conducting trans-basin migrations. Furthermore, the net displacement is independent of the time at large. This means that adult migrations probably do not contribute to whole Baltic scale re-distributions of cod. Furthermore, it implies that regional stock recovery might not lead to recovery of cod in the whole Baltic Sea, but rather to regional regulation of stock size due to density-dependent processes.

WP3 on **Scaling from individuals to populations** has already published two papers addressing the role of small and meso-scale drivers and stressors on recruitment of Gulf of Riga herring. Currently multiple manuscripts are in preparation, addressing the relevance of regional drivers on herring recruitment in the Western Baltic Sea and the interaction between conditions and the dynamic of cod stocks in the central Baltic Sea. Distribution probability maps of juvenile cod and flounder have been developed.

WP4 **Stock Assessments** has addressed severe difficulties related to providing analytical assessment of the eastern Baltic cod stock. The eastern Baltic cod stock was assessed with two models, in which natural mortality in recent years was allowed to increase. The assessment models with natural mortality showing increasing trend perform much better than the standard assessment models in which mortality is assumed constant. These results strongly suggest that natural mortality of cod has markedly increased in recent years. A few trial assessments of herring sub-stocks separated on biological grounds from the Central Baltic herring (CBH) stock were performed. The assessments showed that fishing mortality in these sub-stocks may be significantly higher than for the presently used assessment unit of CBH. The development of biomass and fishing mortality in the Gulf of Finland showed highest differences when compared to CBH dynamics. Evaluation of egg specific gravity measurements on flounder indicate that sub-populations may exist within the deep sea spawning (with pelagic eggs) flounder ecotype; one in SD 24 and SD 25, one in SD 26 and SD 28 separated from fish in the Belt-Sea area (SD 22 and SD 23). No difference in viable hatch or in larval growth up to yolk sac depletion between hybrid and non-hybrid flounder indicates that hybrid flounder individuals may occur in areas where both types occur.

WP5 **Ecosystem based assessment** has initiated critically revising the existing management for Baltic cod, herring and sprat, by taking into account possible modifications and extensions when spatial heterogeneity is accounted for. The activitites taken so far include analyses and publications that support the overall goals of this work package and planning of the high-profile paper to be written as an end-result of the project.

WP6 **Dissemination** has facilitated, by the close contact to various ICES expert groups and Baltic Sea Advisory Council, that project results have been made available to stakeholders and interested public almost in a real time. The overall goal in dissemination work has been to show and apply the importance of spatial heterogeneity in the different activities. Two major joint activities with other relevant BONUS projects included presenting scientific results at ICES ASC Theme session on ‘From genes to ecosystems: spatial heterogeneity and temporal dynamics of the Baltic Sea’ and participating in BONUS Summer school on ’The Baltic Sea: a model for the global future ocean?” Two key results, namely that cod do not migrate a long distance to find better living conditions, and that decrease in condition already started during the 1980s, have been disseminated and will be an important building stone in re-formulating cod population and multispecies assessment models with significant contributions from BONUS INSPIRE. The publishing activities have accelerated during the second year of the project with production of 17 papers. Project web-site has been updated, linking now to publicatons, meta-databases and image galleries.

WP7 **Management** has ensured timely science delivery according to the project workplan via efficient internal communication, systematic contacts with the BONUS Secretariat and continuous monitoring of the progress by the project coordination unit.

2. Scientific and/or technological results achieved

WP 1 Spatial Distributions

Lead: Michele Casini, P5 (SLU)

Scientific highlights

The ichthyoplankton surveys showed that the southern part (SD 26N and SD 28) of the investigation area was more important for the recruitment of sprat. It would be important to clarify whether it happened due to low survival of sprat eggs and larvae in the northern area or due to passive migration of them from north to the south. The mapping of distribution of sprat eggs and larvae in several previous years showed a similar distribution pattern.

Flounder ecotypes studies showed that the sampling in 2015 confirmed the findings of 2014 that both flounder ecotypes (coastal- and deepsea spawners) occurred in SD 25 and 28, and that spawning individuals of the coastal spawning ecotype occurred also at 65-80 m depth in SD 28 suggesting that population mixing with hybridisation may occur (Fig. 1).

Spatio-temporal analyses of cod distribution from pelagic and bottom-trawl surveys evidenced the diel vertical migration at the population level and the importance of desnity-dependence in adult cod distribution.

The Bayesian network model indicated that habitat type plays a very important role in cod distribution but that the interplay to other environmental conditions is non-stationary in a temporal and spatial context.

Studies on feeding ecology of Gulf of Riga herring showed that the entrance of the Gulf is the area worst feeding conditions as evidenced by the highest values of empty stomachs and lower values of stomach fullness (Fig. 2).

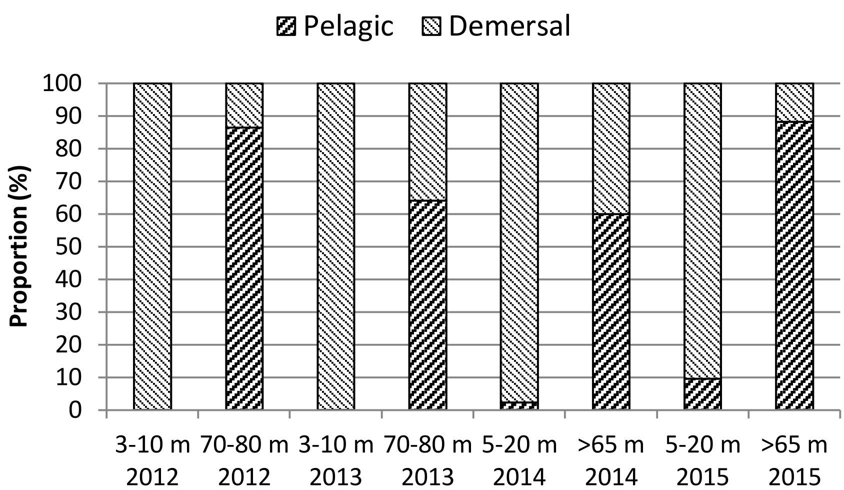

Figure 1. Proportion of spawning individuals of the respective flounder ecotype at different depth off Gotland SD 28 in 2012, 2013 (Nissling and Florin, unpublished) and in 2014 and 2015.

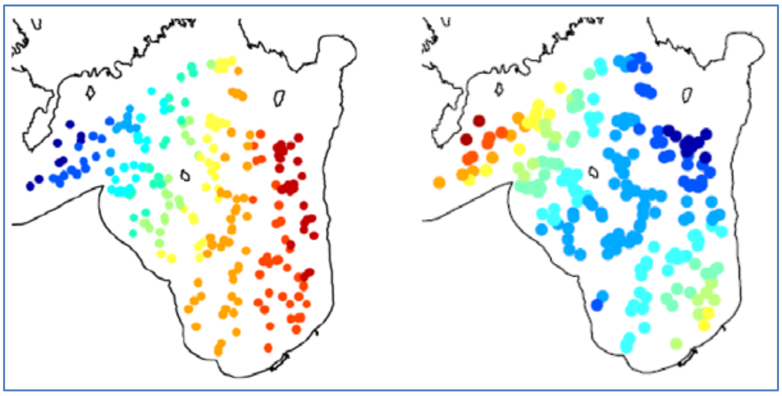

Figure 2. Spatial pattern of the stomach fullness index (left panel; variability 0.23-0.45) and the frequency of empty stomachs (right panel; variability 9-24%) of adult herring in the Gulf of Riga. Blue denotes low and red high values.

Summary

Task 1.1. Data collection and assembly in common databases

Gilllnet fish survey are used to monitor the distribution of the main life stages of cod and flounder during autumn and spring on selected transects covering all possible habitat types and supposed nursery areas at pan-Baltic scale. Collection of relevant habitat data are also undertaken along the same transects. Inventory of settling flounder (0-group) and 1-group flounder using beach seine is performed in several locations around the Baltic to detect the timing and frequency of larvae arrival and abundance of 1-group.

Hydro-acoustic and experimental trawling surveys are used to achieve additional information on distribution and abundance of herring and sprat and their feeding habits. The survey data will be collected in a common database and made available to ICES.

Some dedicated acoustic surveys activity focus on improving the survey performance methodology (comparison of day and night records and trawls). Sprat 0-group data from national surveys are in-depth analysed to be potentially used for the prediction of recruitment, for modification of surveys to obtain more reliable estimates of 0-group, and for identification of the main nursery grounds through ichtyoplankton surveys and application of molecular/biochemical analysis methods.

Gillnets and beach seines surveys

1.1.1. Fishing with multimesh gillnet was made during autumn and spring on 11 selected transects covering all possible habitat types. Apart from standard environmental variables, such as depth, secchi depth, temperature & salinity, also video films were recorded. Due to the scarcity of small cod it was decided

in 2015 to extend the survey to also include large cod. In total 37 fish species were recorded. The total catch of the target species in the spring were 2068 flounders, 55 small cod (≤20cm) and 1015 large cod (>20cm).
More than 1 000 otoliths and genetic samples of flounder and adult cod were taken during the survey. In addition some samples were also taken for priority 2 species, i.e. other flatfishes.
During the gillnet surveys, samples were taken at transects 8 and 10 (ICES SDs 25 and 28, according to BONUS INSPIRE DoW), to study egg (specific gravity) and spermatozoa (mobility at different salinities) characteristics. More samples were taken during a survey with R/V Alkor (GEOMAR) in April 2015 (SDs 22, 24-26 and 28).
Data from 2014 gillnet surveys was put in a common database to initiate habitat modelling and 2015 data are in the process of being uploaded. A protocol for scoring habitat variables from the video-films has been developed and all videos from 2014 and spring 2015 have been scored.

1.1.2. An inventory of newly settled 0-group flounder (including also 1-group) using beach seine was performed at three times during the summer in nine locations around the Baltic to reveal settling pattern of cohorts arriving to the nursery areas, and abundance of 0-gr fish. Sampling was performed from mid-July to mid-September. As in 2014 the abundance of 0-gr individuals was extremely sparse at locations A, B and F. In comparison to 2014 the abundance of 0-gr flounder was very low at location G (SD 25) and H (SD 28 west), and somewhat lower at location C, D and E (SD 28 east). Thus, despite the major inflow event into the Baltic Sea in the winter 2014 involving improved salinity and oxygen conditions, a prerequisite for formation of strong year classes of the deep-sea spawning flounder ecotype, the 2015 flounder year class seem to be weak. At each sampling occasion, also the number of individuals of other species was noted and environmental parameters assessed. Otoliths and tissue samples from individuals of different 0-gr cohorts have been sampled and forwarded within the project for genetic analysis and analysis of otolith chemistry.

Flounder ecotypes and timing of 0-group arrival at the coast

1.1.3. Egg (specific gravity) and spermatozoa (mobility at different salinities) characteristics have been assessed for 118 individuals during the spawning season in 2015 (in total 270 individuals for both 2014 and 2015), to distinguish between the two flounder ecotypes (“pelagic” and “demersal” spawners). Measurements were performed in connection with gill-net surveys at transect 8 and 10 (ICES SDs 25 and 28), and during surveys with R/V Alkor (GEOMAR) in April 2014 and 2015 (SDs 22, 24-26 and 28). Genetic samples (for analysis of population structure), otoliths (age reading and trace element composition) and data on ecotype have been forwarded within the project (task 4.2).

Females of the respective flounder-ecotype was distinguished by egg specific gravity measurements using a density gradient column and compared with glass bulbs of known specific gravity as in Nissling et al. (2002), i.e. at SDs 24-28 individuals with eggs displaying high neutral buoyancy (at ca 11-14 psu) were judged pelagic spawners and those with low neutral buoyancy (at ca 18-23 psu) demersal spawners. For males, spermatozoa mobility at different salinities was used to discriminate between the ecotypes. Spermatozoa mobility was assessed under a microscope at 250X magnification as in Nissling et al. (2002). Fish displaying swimming spermatozoa at <10 psu and higher were judged demersal spawners, and fish with swimming spermatozoa at >10 psu pelagic spawners.

Assessment of egg and spermatozoa characteristics confirmed the findings of the sampling in 2014 that both flounder-ecotypes were present in SD 28 and SD 25. In SD 28 off Gotland spawning individuals of the ecotype with demersal eggs (spawning in coastal areas and at offshore banks at ca 3-25 m depth), were found also at ca 65-80 m depth, and a few individuals characterized as the ecotype with pelagic (spawning in the deep basins) occurred close to the shore at 5-20 m depth (Fig. 1). This indicates that population mixing with hybridisation may occur in areas where both ecotypes are present.

1.1.4. Beach-seine sampling for 0-group (1-gr) flounder was performed at nine locations at three occasions during July-August. As in 2014 the abundance of 0-gr individuals was extremely sparse at locations A, B and F. In comparison to 2014 the abundance of 0-gr flounder was very low at location G (SD 25) and H (SD 28 west), and somewhat lower at location C, D and E (SD 28 east). Data on size frequency distribution (0-gr and 1-gr flounder) and density per sampling site and date have been assessed. Additionally, environmental parameters (temperature, salinity, turbidity, substrate etc) and the number of individuals of other species noted. Genetic samples and otoliths from different 0-gr cohorts have been sampled from mainly fish caught in 2014 as only few 0-gr were caught in 2015, and forwarded within the project (task 4.2). All data have been assembled into a database.

Juvenile flounder were caught by beach-seining (mesh size 4 mm in wings and 2 mm in the codend) as described in Nissling et al., 2007, at 0.2, 0.6 and 1 m depth with five hauls per depth covering 120 m^2 per haul in each sampling site with two sites per location. Sampling was carried out on three occasions; early/mid July, early August and late August/early September. The number of flounder per haul was assessed, individuals measured (length ±0.5 mm) and fish preserved in ethanol for genetic analysis and analysis of otolith chemistry. Additionally the number of individuals of other species (e.g. sticklebacks, gobies etc) was noted per haul and the following environmental parameters assessed at each site and occasion: water temperature, salinity and turbidity, wind speed and direction and at the first occasion type of substrate and coverage of vegetation.

As exemplified from sampling at location g (SD 25) and h (SD 28 west), supposed to capture the year class strength of both flounder ecotypes, recruitment was high in 2014 but poor in 2015. In 2014 totally 457 fish judged as 0-gr (based on length at sampling) were caught at location g (SD 25) and 441 at location h (SD 28) with peaks of newly settled cohorts in both early/mid July and late August/early September. In 2015 only 97 0-gr individuals were caught at location g and 38 individuals at location h with no peak in August/September. In comparison to sampling in earlier years (Martinsson and

Nissling, 2011) the year-class in 2014 seem to be strong but the year-class in 2015 very weak. Despite the major inflow event into the Baltic Sea in the winter 2014 involving improved salinity and oxygen conditions (see task 2.1), a prerequisite for egg survival and formation of strong year classes of the deepsea spawning ecotype (Ustups et al., 2013), recruitment seem to have failed for both ecotypes; the coastal spawning ecotype is abundant off Gotland SD 28 and the offshore spawning type abundant in SD 25.

Ichthyoplankton and acoustic surveys

1.1.5. Ichthyoplankton survey was performed in May 2015 (in the frames of hydro-acoustic survey) in SDs 26N, 28, 29 and 32W. Ichthyoplankton samples were collected with IKS-80 ichthyoplankton net. The samples were collected by vertical trawling from the depth of 100 m or bottom till the surface and by horizontal trawling in the upper water layer. The samples were preserved in formaldehyde solution and treated in laboratory. All sprat eggs were measured and the development stage was determined. The collected sprat larvae were deep-frozen in EMI-UT lab at -80 °C for further RNS/DNS analysis. In total 70 ichthyoplankton samples were collected. Ichthyoplankton survey was also performed in June 2015 in SDs 26N, 28, 29 and 32W. The methodology of the survey was the same as in May. In total 128 ichthyoplankton samples were collected.

1.1.6. Experimental hydro-acoustic survey in September 2015 in SD 28 was performed to improve the methodology of processing of the acoustic data and conducting of the trawling. During the survey 7 hauls were performed during day time and 2 hauls during night time. During the hauls the trawl was pulled in all water layers. The results as a working paper will be presented at ICES WGBIFS meeting in spring 2016.

1.1.7. Studies on clupeid feeding ecology in the Central Baltic Sea were performed using experimental trawling survey. The investigation of feeding ecology of herring and sprat was performed on 5 transects (12 stations) in the ICES SDs 28.2, 29 and 32 in July 2015. 30-minute trawl hauls were performed with conventional pelagic trawl. The catch was sorted according to species composition and the standard biological analyses of sprat and herring were performed. Every trawl was accompanied by zooplankton sampling. The zooplankton was sampled with Juday plankton net using the vertical hauls from bottom to surface. Both zooplankton samples and fish stomachs (964 sprat and 556 herring) are analysed.

Relation to Deliverables and Milestones

D1.1 (Database from first surveys to initiate habitat modelling and spatial distribution analyses, M14) has been fulfilled. Milestone 1 was almost entirely fulfilled (4 sampling campaigns for cod and flatfish performed, M3, M10, M15 and M22), although two Swedish transects in autumn 2015 could not be sampled due to adverse weather conditions. Milestones no. 2 (clupeid spatial overlap and diet survey, M19) and no. 3 (experimental hydroacoustic survey on clupeids, M24) have been achieved.

Task 1.2. Mapping the spatial distribution of fish: linking existing data, new sampling and statistical analyses

Annual and seasonal maps of fish distribution in demersal and pelagic habitats from 1978 onwards are produced using advanced spatial statistics, using the data from existing international monitoring programs. Maps of the spatial distribution of sprat eggs and larvae, and their condition, are also produced using the INSPIRE pelagic field surveys. Indices of spatial overlap between predator/prey and competing species are produced to evaluate the potential predator-prey and competitive relationships in the Baltic Sea. The importance of distribution and overlapping for the diet composition of cod are examined as well as dietary habits of herring and sprat will be investigated.

Statistical habitat modeling is employed to relate the spatial distribution of different life stages of the target fish species to biotic (predators, preys, competitors) and abiotic (temperature, salinity, oxygen) factors, using both existing surveys (BITS, BIAS, BASS databases and newly compiled historical data) and the data from the INSPIRE field surveys (gillnets and ichtyoplankton/acoustic surveys) collected under Task 1.1.

The abundance indices from the gilnest samplings are used to design a reliable recruitment index for cod (integrating BITS data) and flounder, applicable in stock assessment. Otoliths of the captured cod juveniles are used for studies on growth and survival in particular habitats. Habitat characterization of nursery areas is done for settling flounder using the data gathered during the beach seine sampling under Task 1.1.

Maps of sprat egg and larvae abundances, and larvae condition

1.2.1. The main results of the May survey in Sd 26N,28, 29, 32W. The main sprat egg distribution area was the southern part of the survey area namely Sd 26N and 28. In the northern part the abundance of sprat eggs was substantially lower. Sprat larvae were met only in the southern part of the area. The distribution of adult sprat and percentage of the spawning sprat females in the survey area was rather even and could not explain the observed pattern in the distribution of sprat eggs and larvae. The distribution of sprat eggs and larvae was similar to that observed in 2014 the abundances were slightly higher in 2015. In June the sprat eggs distribution was more even in all survey area, however sprat larvae were met mainy in the southern part of the area.

Spatial feeding ecology of adult herring in the Gulf of Riga (to identify essential fish habitats).

1.2.2. Stomach contents of adult herring, collected during hydroacoustic surveys designed to estimate the size of commercially important pelagic fish stocks in the Gulf of Riga, were assembled into a common database and analysed for spatial patterns for the essential feeding ecology parameters (qualitative and quantitative composition). The data originates from in total of 264 trawl hauls conducted by using a pelagic commercial trawl in 30 min hauls. Sampling was performed during the second half of July in all years between

1999 and 2014. The hauling speed was ca. 3 knots, the length of hauls around 2 km. Hauls were targeted at depths (generally at 20m and deeper) where most of the fish biomass was observed using hydroacoustic devices. Stomachs of 20 randomly sampled individuals were stored for the analysis of diet in a 4% formaldehyde solution. The results were: 1) the spatial patterns of the prevalence of empty stomachs indicate that herring has better feeding conditions in the middle and the north-eastern part of the gulf; 2) there is also a pronounced spatial heterogeneity associated with stomach fullness with generally lower values in the north-western part (in the gulf entrance area) and higher values towards the eastern part, which is characterized by lower hydrodynamic activity, more pronounced seasonal thermocline and generally higher temperatures during summer.

Spatio-temporal analyses of cod from the Baltic International Acoustic Surveys (BIAS)

1.2.3. The pelagic control catches from autumn acoustic surveys (BIAS) were used by SLU to study the spatio-temporal dynamics of the cod population in the pelagic waters. The survey covers the whole potential area of Eastern Baltic cod distribution (SDs 25-32), in this way constituting a very useful tool in spatial modeling that can be used together with the data from the ordinary bottom trawl surveys (BITS). The data were analysed with GAMs (Generalized Additive Models) to simulate the spatial distribution (i.e. estimate the CPUE, catch per unit of effort, in Kg/h) of cod in the pelagic water in each ICES statistical rectangle and Subdivision, between 1979-2013. The analyses have been so far made using only Swedish data. In 2016 the analyses will be re-run using also the data from the other countries performing the BIAS. The submission of a manuscript is planned for May 2016.

Spatio-temporal analyses of cod form bottom trawl surveys (BITS and historical data)

1.2.4. Standardized bottom trawl CPUEs (Kg/h) were used by SLU and FGFRI to simulate the fine-scale spatial distribution of cod in the Central Baltic Sea (SDs 25-29) between 1982-2010 using GAMs (Generalized Additive Models). The analyses revealed that the spatial distribution of adult cod is affected by salinity and oxygen, but also by the cod stock size. At high stock sizes, the adult cod population is distributed over a wider area of the Baltic Sea, whereas at low stock sizes the cod population contracts in the most favorable areas (in terms of hydrology), i.e. the southwestern Baltic Sea. These analyses, along with the spatio-temporal patterns in commercial catches, provide indications of the existence of density-dependent habitat selection for the adult Baltic cod. The submission of a manuscript is planned for March 2016.

Compilation of additional historic databases from bottom research surveys which are not in ICES databases

1.2.5. A database on Latvian bottom trawl surveys has been completed by BIOR for the years 1976-1990. In that period the bottom trawl surveys were performed more often and the area coverage was larger than in the later period. All surveys data have been checked in the DATRAS database. For other years the biological information of the hauls has been partly compiled and it will be

combined with the trawl information. Distribution maps of cod and flounder will be produced. A database on Latvian hydro-acoustic surveys has been completed by BIOR for years 1981-1991. The database includes whole acoustic and biological data for 16 surveys in that period. On the base of these data the distribution maps for herring and sprat are produced. A database on Latvian commercial fishery on sprat and cod has been prepared by BIOR for 1995-2014. In this data base individual vessel information is available. The distribution maps of cod and sprat commercial fishery are produced. All prepared bottom trawl and hydro-acoustic survey as well commercial fishery data bases have been uploaded on INSPIRE server.
1.2.5. Data on cod catches from the BIAS and BASS acoustic surveys continued to be compiled from different countries and will be finalized under 2016. The data will provide information on the overall spatio-temporal changes in cod distribution in the pelagic water, which can then be combined with the data from bottom trawl surveys.

Standardization of bottom trawl surveys and analyses of stock trends

1.2.6. The standardization of the trawl catches from the DATRAS database (available at ICES website) and previously conducted surveys (Swedish and Latvia) has been made by SLU. This allows following with survey data the spatio-temporal historical development and the length distribution of different stocks of cod and flounder in the Baltic Sea. Reconstruction of population trends of cod and flounder stocks using the standardized data from bottom trawl surveys (see previous activity) was initiated and planned to be finished in 2016.

Development of Bayesian network model

1.2.7. SU has further developed the Bayesian network model that is able to handle a large amount of spatial and temporal data. 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 the spatial distribution of the Baltic cod biomass. So overall this modeling approach is able to critically 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. At the moment we are estimating which interplay of conditions co-occur when for example cod is high or low. We are working at the moment on paper to explore these dynamics. This will also provide insights into WP 5.

Habitat utilization of Western Baltic herring larvae.

1.2.8. Combining ichthyoplankton monitoring data with case studies on larval abundance in the littoral-and pelagic zone, TI-OF investigated patterns of habitat use of *Clupea harengus* larvae addressing a critical knowledge gap of recent fisheries management. Hypothesizing that larval herring hatched in shallow lagoons of the Baltic Sea develop in a quite different suite of coastal habitats than their counterparts in the neighboring North Sea, pelagic and littoral sites in a major spawning ground of Western Baltic spring spawning herring were sampled. Additionally the vertical distribution of larvae was investigated based on the hypotheses that in the well mixed waters of the lagoon early larval herring is distributed accordingly and not stratified as documented from the open ocean. The results of this study revealed an unexpected loop of habitat use where larvae moved from spawning grounds in shallow littoral habitats to pelagic areas during the first development stages but returned to this habitat in at later stages previous to metamorphosis. Vertical distribution of early larval herring was surprisingly distinct but varied with extension of the water column and larval body length. In general our results demonstrate a quite patterned habitat utilization of early herring life stages in calm, inshore systems. This study implies that fishery assessment and management of fish resources should take into account potential ecological functions of littoral habitats and behavioral distribution mechanisms for dispersal and survival of larval fish. The manuscript has been written and is currently revised by all co-authors. Submission is planned for July 2016.

Zooplankton dataset

1.2.9. The Baltic Sea zooplankton dataset (http://kodu.ut.ee/~riina82/index.html) has been compiled by a joint effort of number of researchers from institutes that conduct or have conducted long-term monitoring of the Baltic Sea. The primary goal of the initiative is to assemble a pan-Baltic raw zooplankton time series data in an effort to look at all-Baltic patterns and ecosystem dynamics at multiple spatial and cross-disciplinary scales. The dataset contains currently species counts and biovolume estimates from over 25000 samples and provided by 9 institutes: Estonian Marine Institute, Tartu University (UT-EMI), Marine Research Centre, Finnish Environment Institute (SYKE), Institute of Food Safety, Animal Health and Environment (BIOR), Latvian Institute of Aquatic Ecology (LHEI), National Marine Fisheries Research Institute (NMFRI), Atlantic Research Institute of Marine Fisheries & Oceanography (AtlantNIRO), Swedish Meteorological and Hydrological Institute (SMHI), the Archipelago Research Institute of the University of Turku, and Open Access Centre for Marine Research of Klaipeda University. The network has a very strong and clear data policy stating that data belongs to data providers and not to the dataset manager.

Among the general questions of high priority is the quantification of the spatiotemporal variability of zooplankton abundance and biomass. Knowing the prominent scales of variability helps to determine the most optimal sampling frequency for the long-term environmental surveys. As a pilot study we have carried out a preliminary analysis to compare the spatial and temporal scales at which the variability of samples is the largest. Analysis includes the abundances of key zooplankton groups: small and large cladocerans and small and large copepods, and data from small lagoons (Pärnu Bay, Vistula and Curonian Lagoons), Gulf of Riga and open Baltic Sea. Patterns of spatiotemporal variability will be looked for in all the zooplankton groups, and in all water bodies listed (Klais et al. in press).

For INSPIRE purpose, the database will be used to characterise prey field availability and variability of clupeids at various spatial scales and habitats (e.g., coastal areas, large gulfs, open sea), as well as serve as an ultimate data source for interannual comparisons. By this way, it will feed into vitally all science-based WP's (WP2-5).

Hydrodynamic modelling

1.2.10. The reconstruction of spatially highly resolved 4-dimensional abiotic hydrodynamic fields, including the oxygen distribution has been continued. The data base (daily averages) comprises now the period 1979-2015. The recent major Baltic Inflow (3rd largest on record) in December 2014 is well reproduced and the fate of the highly saline and oxygenated water masses in central Baltic Sea can be studied in detail.

Relation to Deliverables and Milestones

No Deliverables or Milestones for the Task 1.2 were due during the 2st Project Year.

Task 1.3. Population dynamic consequences of spatio-temporal shifts in predator-prey interactions and implementation into stock assessment

INSPIRE applies and further developed the spatial SMS (stochastic multispecies model) using the information gained under Tasks 1.1 and 1.2. SMS describes stock dynamics of interacting stocks linked together by predation. An extended SMS model with area-dependent predation mortality for cod, herring and sprat has been developed and is applied in INSPIRE. ICES Sub-division based values for predation mortalities of herring and sprat were derived in the hindcast SMS by accounting for the distributions of cod, herring and sprat when estimating the prey-specific consumption rates of cod. The consequences of recently limited spatial overlap between cod, herring and sprat populations are evaluated and incorporated into current population models (e.g. SMS) for later use in stock assessment (WP4).
Furthermore, a historical reconstruction of the food-web is performed to understand spatial distributions in response to factors different from those observed during the past few decades. Especially, cod-flatfishes interaction is reconstructed back in time under oligotrophic conditions and low fishing pressure.

Multispecies models

The recently surfaced difficulties in age determination for cod that render both single- and multispecies cod stock assessments difficult to impossible for the time being, including estimation of predation rates by cod on herring and sprat. INSPIRE developed an age-independent model to estimate cod growth trajectories and their dependence on prey availability. This growth model will be used to develop a new multispiecies forecast model that is independent of age determination and works solely length-based. The new multispieces model will contain the effect of predator-prey spatial overlap, too, and can be applied for the envisaged management strategy evaluations.

Hydrodynamic modeling

1.3.2. For the static spatio-temporal modeling of Baltic cod, monthly averages of the hydrodynamic model output have been calculated (3-dimensional fields of temperature, salinity and oxygen) for the period 1979-2014. Hydrodynamic model data serve as forcing conditions for the SMS model.

Relation to Deliverables and Milestones

No Deliverables or Milestones for the Task 1.2 were due during the 2st Project Year.

3 Deviations from the work plan

Two transects in the gillnet survey could not be fished in autumn 2015 due to bad weather conditions. No other deviations from the work plan have occurred for WP1.

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WP 2 Passive movements, active migrations, and habitat connectivity

Lead: Christian Möllmann, P8 (UHAM)

1. Scientific highlights

Spawning areas of eastern Baltic cod revisited: Using hydrodynamic modelling to identify hotspots.

Distinct spatial distribution patterns of eastern Baltic cod early life stages and strong variations in Baltic Sea circulation patterns are a prerequisite to investigate the existence of self-sustaining components and mixed populations of cod within the Baltic Sea. A hydrodynamic model combined with a Lagrangian particle tracking technique was utilized to provide long-term knowledge of environmentally-related survival probability and drift of eastern Baltic cod eggs and yolk-sac larvae. Simulations were performed to quantify processes generating heterogeneity in spatial distribution of Baltic cod early life stages. We evaluated the environmental conditions in the different spawning grounds with respect to suitability for spawning, egg survival probability, and estimated the population connectivity of eastern Baltic cod eggs and yolk-sac larvae between the different spawning grounds. The extent of Baltic cod eggs represented as virtual drifters is primarily determined by oxygen and salinity conditions and the ability to obtain neutral buoyancy in the water column, which define the habitat requirement to which species' physiology is suited. Eggs initially released as drifters in the westernmost spawning grounds were more affected by sedimentation than those released in the eastern spawning grounds. For all spawning areas within the Baltic Sea temperature dependent mortality was only evident after severe winters. Egg buoyancy in relation to topographic features like bottom sills and strong bottom slopes could appear as a barrier for the transport of Baltic cod eggs and could potentially limit the connectivity of Baltic cod early life stages between the different basins in the central and eastern Baltic Sea.

Spatio-temporal trends in stock mixing of eastern and western Baltic cod in the Arkona Basin and the implications for recruitment.

In the Baltic Sea, two genetically distinct cod populations occur, the "Eastern" Baltic cod in ICES SDs 22-32 and the "Western" Baltic cod in SDs 22-24. Since 2006, cod abundance has increased 5 fold in the Arkona Basin in the eastern part of the "Western" cod's management unit (SD 24), but remained constant in SD 22, presumably due to mixing of the two stocks. The spatio-temporal dynamics of stock mixing were analysed using shape analysis of archived otolith, and the impact of "Eastern" cod's immigration on recruitment by hydrographic drift modelling. The percentage of "Eastern" Baltic cod in the Arkona Basin increased from ca. 20 % before 2005 to > 60 % in recent years. The spatial resolution of stock mixing suggests immigration occurring north of Bornholm, but propagating throughout the Arkona Basin. An age-related trend in immigration was evident, which started with age 4 year cod followed by progressively older individuals. The immigration cannot be attributed to spawning migration, as no seasonal trend in stock mixing was observed. Only between 20-50% of the available habitat was suitable for successful spawning of “Eastern” cod, limited by primarily low salinity. Best conditions occurred irregularly in May-end June, interspersed with years where successful spawning was virtually impossible. On average, only 19 % of the eggs survive to the end of the yolk-sac, with mortality primarily after bottom contact due to low salinity. The general drift direction of the surviving larvae was towards the east. Albeit considerable, the immigration of “Eastern” cod does therefore not seem to contribute significantly to “Western” Baltic cod’s recruitment.

Connectivity of larval cod in the transition area between North Sea and Baltic Sea and potential implications for fisheries management.

Connectivity of pelagic, early life stages via transport by ocean currents is of particular interest, as it may affect survival chances of offspring, recruitment success and mixing of stocks across management units. Based on drift model studies, the transport patterns of exogenously feeding cod larvae in the transition area between North Sea and Baltic was investigated in order to i) determine long-term trends and variability in advective transport of larvae from spawning grounds to juvenile nursery areas, ii) estimate the degree of exchange between different management areas and iii) compare the results with spatial distributions of juvenile cod. The transport of larvae showed a high intra- and inter-annual variability, but also some general, consistent patterns of retention within and dispersion to different management areas. Good agreement of drifter end positions, representing potential juvenile settlement areas, with actual catches of juveniles from bottom trawl surveys suggests that the drift simulations provide reasonable estimates of early life stage connectivity between cod populations in the investigated areas. High exchange rates of drifters between management areas of up to ca. 70% suggest that cod populations in the investigated areas are demographically correlated. Results are discussed in relation to their relevance for stock structuring, fish stock assessment and management.

Migration and migration rates of annual individuals

Tag-recapture data-points indicate that cod in general do not perform long-distance migrations, but that only a small fraction (<10%) of the tagged population is conducting trans-basin migrations. Furthermore, the net displacement is independent of the time at large. This means that adult migrations probably do not contribute to whole Baltic scale re-distributions of cod. Furthermore, it implies that regional stock recovery might not lead to recovery of cod in the whole Baltic Sea, but rather to regional regulation of stock size due to density-dependent processes. An exception is the exchange between the Bornholm and Arkona Basins. The impact of eastern cod immigration on recruitment in the western Baltic Sea was investigated using hydrographic drift modelling (see above). The percentage of eastern Baltic cod in the Arkona Basin increased from ca. 30% before 2005 to ca. 80% in recent years. Geographic patterns in stock mixing with a pronounced east–west trend suggest that immigration occurs north of Bornholm, but propagates throughout the Arkona Basin. The immigration cannot be attributed to spawning migration, as no seasonal trend in stock mixing was observed. These migrations affect the number of effective spawners. For the time period 1993–2010, our results revealed large variations in the horizontal extent of spawning habitat (1 000–20 000 km^2) and oxygen-dependent egg survival (10–80%). At the same time, the spatial pattern of landings has changed substantially as the fishery of cod has shrunk to the southern and southwestern areas and the importance of north-eastern areas has increased in sprat and herring fishery.

2. Summary

Work-package 2 contains statistical and process-based analyses of movements of the focal species at different temporal and spatial scales and in different life-stages. Besides quantifying these movements, emphasis is put on the characterization of obstacles for the transport or movement between nursery and feeding habitats, between feeding and spawning habitat, and (closing the life cycle) between early life stages habitats and nursery grounds. This includes the assessment-relevant movements between ICES sub-divisions.

Task 2.1 Transport of early life stages from spawning area to nursery grounds

In this task an existing hydrodynamic model (BSIOM) and a Lagrangian particle-tracking technique are used to evaluate drift patterns of cod and flounder eggs and larvae. Using this model suite long-term knowledge on environmentally-related survival probability and drift of Eastern Baltic cod eggs and yolk-sac larvae were provided. Simulations were performed to quantify processes generating heterogeneity in spatial distribution of cod early life stages. The environmental conditions were tested in the different spawning grounds for suitability of spawning and egg survival probability. Further, the population connectivity of eastern Baltic cod eggs and yolk-sac larvae was estimated. The development of the tracking model and according model simualtions are underway for flounder.

Three manuscripts have been published or accepted for publication, hence Deliverable D2.2 [Manuscripts (2) on tracking eggs and larvae M18] has been delivered as planned. The same applies to Milestone M8 [Larval early life-history stages tracking model development: Model completed M24].

Available data (earlier measurements and new measurement within the project; task 1.1) on egg specific gravity of flounder in different ICES SDs have been compiled and included in modelling of drift pattern and survival of eggs and larvae for deepsea spawning flounder. Additionally, eggs and larvae of flounder have been incubated at different temperatures (2-10 °C) for assessment of developmental time and survival probabilities and included in the model. Further, data on egg specific gravity have been used to assess habitat suitability for flounder eggs in the three main spawning areas (Bornholm Basin, Gdansk Deep and Gotland Basin) before and after the major inflow event in the winter 2014.

Egg specific gravity of flounder differs among spawning areas as an adaptation to ambient salinity conditions indicating the occurrence of subpopulations. The viable hatch was significantly lower at 2°C and larval growth and development affected at ≤4°C. Habitat suitability for egg survival was significantly improved in the Bornholm Basin and the Gdansk Deep after the inflow event but not in the Gotland Basin.

Fertilisation and incubation of egg-batches were performed and the viable hatch was assessed as the number of larvae with normal swimming functions (Nissling et al., 1998). Habitat suitability for egg survival of flounder was assessed by environmental threshold levels for egg survival based on minimum values for temperature and oxygen; oxygen levels < 1.0 ml $O_2 \cdot l^{-1}$, or temperatures < 2.0 °C as in Hinrichsen et al. (under review). Egg survival probabilities were then evaluated by combining data on egg specific gravity and hydrographic data from CTD-casts (from surveys with R/V Alkor in April 2014 and in April 2015).

Analysis of egg specific gravity of eggs from females from different deep basins/ICES SD 22-26 and SD 28 (data from Nissling et al., 2002; Christoph Petereit, GEOMAR and INSPIRE) showed that egg specific gravity (neutral egg buoyancy) differ among spawning areas, i.e. should be accounted for in modelling and may be used as a tool to identify subpopulations. No difference in egg specific gravity was found between eggs from SD 24 and SD 25, and between eggs from SD 26 and SD 28 suggesting that that fish from SD 24 and 25, and from SD 26 and 28, respectively belong to the same subpopulation.

The viable hatch differed significantly between temperatures but not between females, showing a strong effect of temperature on the viable hatch; on average 50 % at 2 °C and approximately 90 % at 4-10 °C (Fig. 3). Larval size at the time of yolk sac depletion differed significantly between temperatures and also between females with the largest larvae at 6 and 8 °C and significantly smaller at 2, 4 and 10 °C .

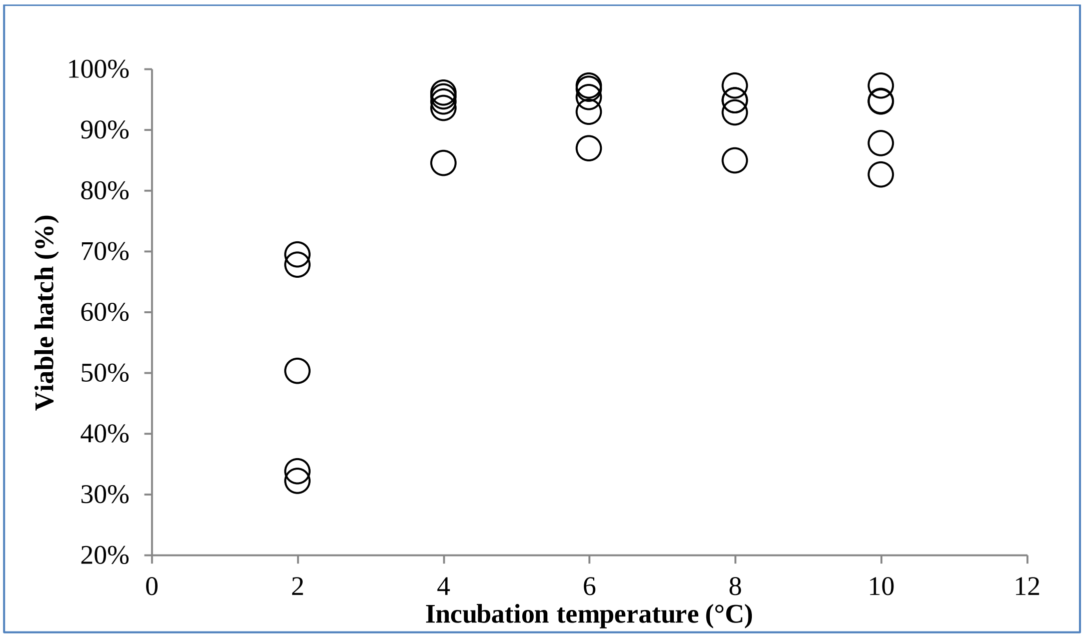

Figure 3. Viable hatch (%) of flounder eggs incubated at different temperatures (°C).

The major inflow event in the winter 2014-2015 resulted in improved conditions for egg development below the halocline, i.e. in the main spawning areas for flounder with pelagic eggs. In the Bornholm Basin and the Gdansk deep both salinity and oxygen concentrations increased whereas in the Gotland basin there was an increase in salinity while oxygen conditions remained low. Higher salinities resulted in a significant change in depth range at which eggs obtained neutral buoyancy, and the change in depth range for egg development affected egg survival probabilities significantly. In the Bornholm Basin and the Gdansk Deep opportunities for egg survival increased, whereas probabilities for egg survival in the Gotland Basin was low in both years (Fig. 4).

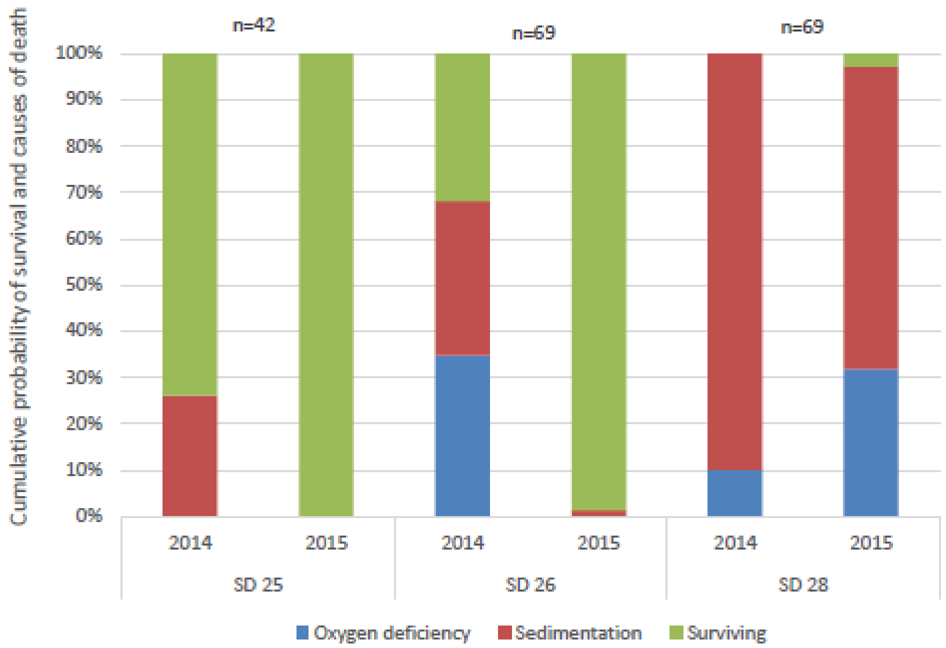

Figure 4. Survival probabilities and causes of death for flounder eggs in the Bornholm Basin, the Gdansk Deep and Gotland Basin in April 2014 and 2015.

Additional work has been conducted on spatio-temporal distribution of cod. The pelagic control catches from autumn acoustic surveys (BIAS) were used to study the spatio-temporal dynamics of the cod population in the pelagic waters. The survey covers the whole potential area of Eastern Baltic cod distribution (SDs 25-32), in this way constituting a very useful tool in spatial modeling that can be used together with the data from the ordinary bottom trawl surveys (BITS). The data were analysed with GAMs (Generalized Additive Models) to simulate the spatial distribution (i.e. estimate the CPUE, catch per unit of effort, in Kg/h) of cod in the pelagic water in each ICES statistical rectangle and Subdivision, between 1979-2013. The model revealed a clear day/night pattern in CPUE with catches being higher at night-time and lower during the day-time, demonstrating the overall migration of adult cod to the pelagic habitat during night. The analyses have been so far made using only Swedish data. In 2016 the analyses will be re-run using also the data from the other countries performing the BIAS.

Furthermore, standardized bottom trawl CPUEs (Kg/h) were used to simulate the fine-scale spatial distribution of cod in the Central Baltic Sea (SDs 25-29) between 1982-2010 using GAMs (Generalized Additive Models). The analyses revealed that the spatial distribution of adult cod is affected by salinity and oxygen, but also by the cod stock size. At high stock sizes, the adult cod population is distributed over a wider area of the Baltic Sea, whereas at low stock sizes the cod population contracts in the most favorable areas (in terms of hydrology), i.e. the southwestern Baltic Sea. These analyses, along with the spatio-temporal patterns in commercial catches, provide indications of the existence of density-dependent habitat selection for the adult Baltic cod.

Task 2.2 Migrations of adult individuals

In this task net-migrations rates between adjacent sub-divisions will be estimated using existing tagging and acoustic survey data from the partner institutes. As a baseline for this study a database on traditional tagging data and a respective research plan for their analyses has been created and submitted as scheduled in Deliverable D2.1 [Database on traditional tagging data; 12]. Accordingly Milestone M7 [Fish tagging database: Database completed M12] has been achieved as planned. Furthermore, migration rates between basins have been estimated for cod, herring and sprat. These estimates are going to be analysed in relation to subdivison based estimates of species density, predator abundance and competitor abundance. The resulting net migration estimates will be applied in the sub-division species forecasts of cod, herring and sprat distributions. Furthermore, a great deal of work has been done to simultaneously estimate the effects of fishing and environmental impact on fish recruitment. Combining these estimates has been necessary to counteract the very high sensitivity of spatial models towards using migration rates only for estimating displacement rates. The work on migrtaions and migration rates indicates that density dependent habitat selection does not occur across basins, but that migrations are limited to spawning migrations, partially between basins especially the Bornholm and the Arkona Basins, and edge effects corresponding to undirected, random migrations. The part of the populations that undertakes directed movements over long distances is very limited. These findings will form the basis for the spatially explicit models in work-package 4, Task 4.1. This work has been submitted as scheduled in Deliverables D2.3 [Manuscripts (2) on migrations of adult individuals; M24] and D2.4 [Report on migration estimates; M24].

Eventually a review of historical literature on Baltic herring population dynamics has been initiated as additional work within INSPIRE with the aims to collect major findings on herring ecology from non-English literature and to synthesize findings according to the driving factors of spatial distribution and survival dynamics. A database for historic and current literature on herring ecology was established. Collection of historic data sets and literature from all parts of the Baltic Sea will be continued during 2016. The review (among others) will deliver additional information on herring migration changes.

Task 2.3 Small scale movements relevant for species interactions

In this task small-scale movements of cod, herring and sprat, such as school formation, evasive reaction, distance between schools, reactions to the presence of predators (including fishers) will be analysed using existing acoustic and data storage tag data. The small scale movements knowledge will be used (i) to test hypotheses on density dependent emigration on a sub-basin scale and (ii) to understand if the exchange between ICES sub-divisions has other reasons than reproductive success or fishery, that is availability of prey or predation risk, or a combination of different factors. Drivers of species distribution will be also investigated at the small temporal and spatial scale using high resolving acoustic, video and plankton net (prey field) data, generated in a dedicated survey activity (pilot study).

Data for this task have been gathered including historical hydroacoustic recordings and especially on a dedicated survey in March/April 2015 investigating the small-scale predator prey distribution using modern ocean observation techniques such as the Video-Plankton-Recorder (VPR) and the Laser Optical Plankton Recorder (LOPC). Furthermore a Baltic Sea zooplankton dataset has been compiled by a joint effort of number of researchers from institutes that conduct or have conducted long-term monitoring of the Baltic Sea under WP1 (under Task 1.1). The primary goal of the initiative is to assemble a pan-Baltic raw zooplankton time series data in an effort to look at all-Baltic patterns and ecosystem dynamics at multiple spatial and cross-disciplinary scales.

The work in this Task will result in Deliverable D2.5 [Database on small scale distribution of cod, herring and sprat M30] and D2.6 [Manuscript on small scale movements M36], which are both expected to be delivered as scheduled.

3. Deviations from the workplan

There were no deviations from the workplan.

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WP 3 Scaling from individuals to populations

Lead: Patrick Polte, P7 (TI-OF)

1. Scientific highlights

Two papers were already published addressing the role of small and meso-scale drivers and stressors on the recruitment of the Gulf of Riga spring spawning herring. The first study identified the relation among regional climatic conditions and the temporal overlap between larval herring and its prey. It also determined critical processes responsible for the seasonal and annual variation in larval herring abundance. The second study dertermined daily growth rates and instantaneous mortality of larval herring. Results indicate that vital rates vary at small spatial scales. Furthermore, the impact of key environmental conditions on vital rates was investigated.

Currently multiple manuscripts are in preparation: The first paper is about the relevance of regional drivers on herring recruitment in the Western Baltic Sea (D3.3). Along the hypothesis that for a species with distinct spawning site fidelity, small scale stressors are transported to overall population level, the focus of the study is on the impact of regional storm events for Baltic Sea herring recruitment. Field experiments on pre- and post-impact data on herring egg mortality indicate the importance of the shallow vegetated zone for spawning herring and a 90% egg loss rate due to storm induced wave action. Another manuscript deals with the interaction between conditions and the dynamic of cod stocks in the central Baltic Sea and investigates the environmental conditions under which the cod stock is high (D3.2). It is concluded that the habitat type plays an important role but interaction with large scale environmental conditions is dynamic and therefore conditions are not stable on a temporal and spatial scale. Other highlights are the provided distribution probability maps of juvenile cod and flounder. The simulated spatial distribution patterns of eastern Baltic cod and flounder eggs (WP2) could serve as release locations for the drifting larvae of both species. In cooperation with colleagues from BIO-C3 the hydrodynamic model of the Baltic Sea in combination with a Lagrangian particle tracking method will provide distribution probability maps of juvenile cod and flounder (D3.1). Model runs have been updated for the time period 1979-2015. Further model runs for 2016 and subsequent Lagrangian drift tracking model runs will be done if the corresponding atmospheric forcing will be available. Settlement probability maps of juveniles will be estimated in relation to bottom depths as well as to the oxygen concentrations at the bottom.

2. Summary

The scope of this WP is to quantify the impact of small and meso-scale ecosystem drivers and stressors on population scale, spatial distributions and species recruitment dynamics. Especially for fish species with a high degree of habitat fidelity according to spawning grounds or nursery areas, impacts of local hazards might be transported to larger spatial scales and affect entire stock dynamics. The focus of the WP is on the contribution of certain spawning grounds/juvenile habitats to adult populations and effects of local scale mortality, for example hazards due to hot spot fisheries, predation on aggregations of juveniles, or regional climatic extremes such as severe storm events.

The question to be addressed is whether local hazards might shape large scale population abundance and recruitment strength and thus spatial distribution patterns.

WP 3 includes two major objectives:
1. To develop methods to scale individual movements of cod, herring, sprat and flounder (early life stages) to population distributions.
2. To perform process-studies collecting basic knowledge on regional hazards for population dynamics of Baltic herring and cod

Task 3.1 Scaling individual movements to populations' spatial distributions

On the basis of beach seine surveys we have produced distribution maps for 0-group flounder and have collected otoliths from flounder which have been used for their age determination counting the daily rings. Additionally otoliths have been used to perform microchemistry analysis which potentially will allow to link particular nursery areas with the original spawning sites.

Observed distribution patterns of cod, herring, sprat and flounder early life stages will be put in relation to individual movement and migration analysis (WP2). So far the hydrodynamic model (BSIOM) and a Lagrangian particle-tracking technique have been used to evaluate drift patterns of cod and flounder eggs and larvae. Simulations were performed to quantify processes generating heterogeneity in spatial distribution of cod early life stages. The environmental conditions were tested in the different spawning grounds for suitability of spawning and egg survival probability. Furthermore, the population connectivity of eastern Baltic cod eggs and yolk-sac larvae was estimated. (see linkages to Deliverable D2.2 and D2.3). The development of the tracking model and according model simulations are in progress for flounder. The aim is to provide temporally and spatially resolved distribution and settlement probability maps focusing on relative densities of juveniles within the different nursery areas. Results will be published within the manuscript on the impact of active migrations in the observed distributional changes of cod, herring and sprat (D3.1). It is expected to have a final manuscript on distribution probability maps for juvenile cod and flounder as scheduled in Month 36.

In addition we further developed the Bayesian network model that is able to handle a large amount of spatial and temporal data. 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 and habitat type), environmental variables (spring and summer temperatures, phosphate and nitrate concentrations, salinity, anoxic levels), trophic parameters (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. Model results on the non-stationary dynamics through 41 years highlights the role of environmental and trophic changes on the spatial distribution of the Baltic cod biomass. Accordingly, overall this modeling approach is able to critically 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. Currently, we are estimating the interaction of conditions co-occurring at a high or low cod stock situation for the manuscript on the impact of active migrations in the observed distributional changes of cod, herring and sprat which is expected to be finalized as scheduled in Month 40 (D3.2).

As described, first results are achieved to develop methods to scale individual movements of cod, herring, sprat and flounder to population distributions, the status of the model development is according to milestone No. 9 "Scaling model for fish population distributions" and is established by M24.

The pelagic control catches from autumn acoustic surveys (BIAS) were used to study the spatio-temporal dynamics of the cod population in the pelagic waters. The survey covers the whole potential area of Eastern Baltic cod distribution (SDs 25-32), in this way constituting a very useful tool in spatial modeling that can be used together with the data from the ordinary bottom trawl surveys (BITS). The data were analysed with GAMs (Generalized Additive Models) to simulate the spatial distribution (i.e. estimate the CPUE, catch per unit of effort, in Kg/h) of cod in the pelagic water in each ICES statistical rectangle and Subdivision, between 1979 and 2013. In 2016 the analyses will be re-run using also the data from the other countries performing the BIAS. These analyses will feed into multispecies models to scale the migrations to the relative distributions between ICES Subdivisions.

Standardized bottom trawl CPUEs (Kg/h) were used to simulate the fine-scale spatial distribution of cod in the Central Baltic Sea (SDs 25-29) between 1982-2010 using GAMs (Generalized Additive Models). The analyses revealed that the spatial distribution of adult cod is affected by salinity and oxygen, but also by the cod stock size. At high stock sizes, the adult cod population is distributed over a wider area of the Baltic Sea, whereas at low stock sizes the cod population contracts in the most favorable areas (in terms of hydrology), i.e. the southwestern Baltic Sea. These analyses, along with the spatio-temporal patterns in commercial catches, provide indications of the existence of density-dependent habitat selection for the adult Baltic cod. Also these analyses will feed into multispecies models to scale the migrations to the relative distributions between ICES Subdivisions.

Task 3.2 Quantifying effects of regional hazards on larger scale productivity and spatial distributions

In the Central Baltic Sea, we investigates the role of various local and regional drivers and stressors for the herring recruitment in the Gulf of Riga. In Pärnu Bay, one of the key spawning and larval fish nursery areas, larval herring abundance and growth was analysed in relation to variables, such as the: sum of monthly mean air temperatures from January to March, larval prey density, local sea surface temperatures, winter air temperatures and the zooplankton prey spectrum. The work performed includes two different activities:1. Investigating the relationship between larval production in Pärnu Bay and overall Gulf of Riga herring recruitment and the impact of regional environmental conditions. The study included the analysis of herring larvae weekly collected on 9 stations in Pärnu Bay (Fig. 5) during 2003-2014. The specific objectives of the study were to (i) investigate the relationship between larval fish and recruitment abundance (source: ICES reports); (ii) identify how regional climatic effects influence temporal overlap between larval herring and its prey; (iii) determine critical processes responsible for the seasonal and annual variation in larval herring abundance. Local factors influencing larval herring growth and mortality were investigated by analysing herring larvae, collected at daily resolution during two weeks in June 2011 in 3 inshore stations in Pärnu Bay in relation to environmental conditions. The specific aims of this study were to: (i) identify daily growth rate and instantaneous mortality of the larval herring; (ii) determine whether the vital rates vary at small spatial scales; (iii) identify the impact of key environmental conditions on vital rates.

Results indicate that the abundance of 1-year old Gulf of Riga herring is significantly determined by the number of large larvae (> 17 mm) in the shallow and sheltered Pärnu Bay. The abundance of large larvae showed a dome-shaped relationship with sea surface temperatures experienced after hatching. Thus it is concluded that water temperatures in shallow, transitional areas influences the survival of large larve, which in turn, determines Gulf of Riga herring recruitment strength (Arula et al. 2015). As feeding conditions for larval herring in terms of the density of suitable prey were most likely favorable and supported the observed very high growth rates, prey availability cannot be considered as a limiting factor for the spring herring recruitment originating from coastal areas in the Gulf of Riga (Arula et al. 2016).

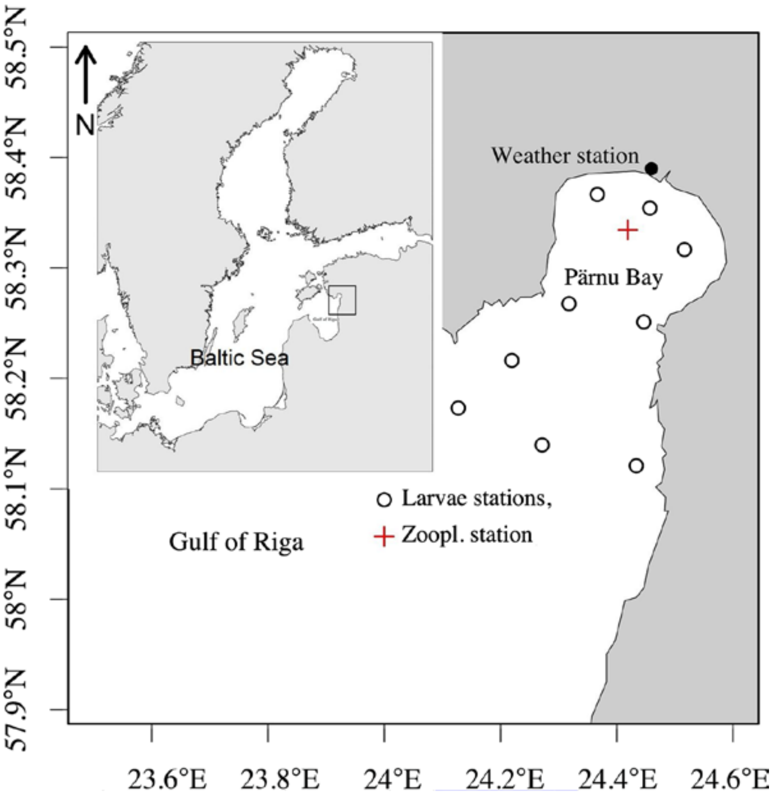

Figure 5. Location of larval herring and zooplankton sampling stations in the NE of the Gulf of Riga.

The other focus is on the herring population of the Western Baltic. Here we investigate the importance of coastal herring spawning grounds in inner coastal waters. Coastal areas are essential spawning and nursery habitats for many fish species, however they are also subject to multiple anthropogenic threats. Within these shallow waters, submerged aquatic vegetation (SAV) often plays a crucial role in structuring the habitat and providing suitable substrate for feeding, predator avoidance and spawning. Some commercially important fish species, such as Atlantic herring in the Western Baltic Sea, are strongly depending on the availability of appropriate spawning beds formed by meadows of SAV in shallow brackish lagoons. The SAV composition within these estuarine systems usually follows a depth-dependent gradient with a pondweed community in water depths below 2 meters and a seagrass dominated zone between 2 and 4 meters. Hypothesizing a distinct habitat-related utilization of these different zones as spawning beds, SAV meadows at fixed transects of different water depths were sampled weekly during the spring herring spawning season (March to June). Herring spawn concentrations and egg mortalities were quantified along with the amount and composition of SAV. Additionally, hydrographical features were measured to analyze the impact of these parameters on spawning intensity and egg mortality. Results showed a strong seasonal variation in spawning bed utilization but also strong inter-annual changes in SAV-composition (e.g. increasing amount of floating algal mats) and resulting spawning intensities and egg mortalities. Considering the persistent eutrophication-related general trend in decreasing SAV meadows, results underline the demand for an integrated and sustainable management of shallow coastal spawning grounds. Another study, focused on the role of small-scale stressors for the Baltic herring recruitment strength by analyzing the impact of storm events on herring egg mortality. During spawning time in spring herring migrate into their spawning areas to attach their demersal eggs on macrophytes. In the study area Greifswald Bay spawning substrate for herring is limited in the shallow littoral zone with growth limits of 3.5 meters, so these shallow vegetated zones are affected by wind induced hydrodynamics. Therefore we investigate the impact of storm events on herring egg mortality and thus on reproduction success in one important spawning ground located in the south of Greifswald Bay. Before and after a multiple-day storm event we took samples in three different depth zones. Furthermore we performed a beach litter sampling from a beach section at the lee site of the investigation area. Preliminary results show the importance of the shallow vegetated zone for spawning herring and a macrophyte loss rate of 26 % after the storm event in the shallow vegetated zone. The challenge is to evaluate the importance of particular spawning areas to the total population and to analyze local scale mortality and the impact on higher spatial scales. We hypothesize that single nursery areas provide a superior contribution to the WBSS herring stock by focusing the questions: Which spawning areas provide the most recruits and which local stressors have an impact on recruitment success? For investigating this assumption, we performed a pilot study using the method of elemental fingerprinting in herring otoliths. Preliminary results show a clear difference in element concentration of herring juvenile otoliths caught in different spawning areas. We are planning to increase efforts by using larval and adult herring otoliths. In summary we already could increase our knowledge on regional hazards for population dynamics of Baltic herring, and will deliver a manuscript on the role of small- and meso-scale drivers and stressors for overall Baltic herring recruitment as scheduled in Month 40.

3. Deviations from the workplan

There were no deviations from the workplan.

References

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Arula, T., Raid, T., Simm, M., Ojaveer, H. 2016. Temperature-driven changes in early life-history stages influence the Gulf of Riga spring spawning herring (*Clupea harengus m*.) recruitment abundance. Hydrobiologia 767: 125-135.

WP 4 Stock Assessments

Lead: Jan Horbovy, P3 (MIR-PIB)

1. Scientific highlights

As it was indicated in 1st year report, ICES had (and still has) severe difficulties with providing analytical assessment of eastern Baltic cod stock, while such assessment is important for fulfilling Task 4.1. So, as it was suggested in 1st year report some additional work has been undertaken in relation to eastern cod assessment, as without such assessment it may be difficult to correctly determine the dynamics of clupeids stocks.

The eastern Baltic cod stock was assessed with two models, in which natural mortality in recent years was allowed to increase (or be dependent on weight of cod, which drastically declined in recent years). The applied models were the age-structured CAGEAN and difference stock-production model, as it was relatively easy to implement into these models varying natural mortality and estimate this mortality within the models. It was shown that the assessment models with natural mortality showing increasing trend perform much better that the standard assessment models in which M is assumed constant; they are better both in diagnostics of the model quality and in consistency with the trends in survey indices of stock size. In addition, a stock similar to eastern cod with natural mortality increasing in recent years was generated. It was shown that the assessment of such stock using constant natural mortality performs similarly badly as recent ICES assessments in terms of model diagnostics. Obtained results strongly suggest that natural mortality of cod in recent years markedly increased.

A few trial assessments of herring sub-stocks separated on biological grounds from the Central Baltic herring (CBH) stock were performed. The assessments showed that fishing mortality in these sub-stocks may be significantly higher than the F for presently used assessment unit of CBH. The development of biomass and F in Gulf of Finland showed highest differences when compared to CBH dynamics. The work is in progress and further analyses are required to provide firm conclusions on the effects of combining sub-stocks into assessment unit of CBH on management of these stocks.

Evaluation of egg specific gravity measurements on flounder indicate that sub-populations may exist within the deep sea spawning (with pelagic eggs) flounder ecotype; one in SD 24 and SD 25, one in SD 26 and SD 28 separated from fish in the Belt-Sea area (SD 22 and SD 23). No difference in viable hatch or in larval growth up to yolk sac depletion between hybrid and non-hybrid flounder indicates that hybrid flounder individuals may occur in areas where both types occur.

2. Summary

The WP4 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 assessment,

2. to provide assessment of the status of flatfish in the Baltic, as a basis for quantitative management of these stocks.

First deliverables for that WP are scheduled on month 36; these are:
D4.1. Report on assessments of herring, sprat and cod, including spatial effects (biomass distribution, natural populations)
D4.2. Database for flounder assessment or stock evaluation by stock.

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

Standard stock assessment approaches used by ICES do not take into account differences in spatial distribution of fish within assessment units/stocks, while decreasing overlap between cod and clupeids has been observed for several years. The aim of this task is to include differences in spatial distribution of fish stocks and fish migrations into the assessment models. Several approaches will be tested and applied, including spatially disaggregated age-structured methods, models which account for migration, multispecies models. In multispecies models change in predator-prey overlap will be addressed. Assessment of sprat and herring in the present assessment units (sprat in the whole Baltic and Central Baltic herring (sub-div. 25-29,32) will be verified by applying assessment models to stocks identified earlier on biological grounds in these units.

In 2014 and 2015, International Council for the Exploration of the Sea (ICES) unexpectedly was unable to provide an analytical assessment of eastern Baltic cod stock, and factors such as data issues, assessment methodology, and the ecological situation of cod were indicated as the reasons for this failure (ICES, 2015). Therefore, some effort was put to perform assessment of the eastern Baltic cod stock as such assessment (or stock evaluation) is necessary to include cod effects on clupeids through cod predation and extend of overlap of cod and clupeids stocks. Some evidence suggests that the natural mortality (M) of cod could substantially increase in recent years and the selectivity could change.

For the analysis of the eastern cod stock dynamics two mathematical models were used: age-structured CAGEAN (Deriso et al., 1985) and difference stock-production model (Horbowy, 1992). In the models, both constant and increasing natural mortalities were permitted. In the CAGEAN model, the effects of selectivity related to the cod size on the cod assessment were also analysed. In addition, stock with characteristics similar to Baltic cod stock and increasing natural mortality was generated and assessed with the age-structured model using both constant and increasing M. It was shown that models with increasing natural mortality of cod in recent years perform much better than models with constant natural mortality in terms of the distribution of residuals and retrospective patterns. The models with size-dependent selectivity did not perform better than other standard assessments. The assessment of generated stock (where the natural mortality was increasing) with constant natural mortality in the assessment model showed a poor distribution of residuals and strong retrospective patterns, similarly to the ICES eastern cod assessment with constant M.

The conducted simulations strongly suggest that the main reason for the poor recent cod assessment is the increase in natural mortality, which is not considered in the assessment methodology. The models estimates of natural mortality (measured as average yearly M at age 3 and older weighted by stock biomass at age) indicate its increase from about 0.3 in 2007 to 0.6-0.7 in 2011-2013 (Fig. 6). These levels are estimated within the model and should be treated with caution, however, the results suggest the need for additional work on the M estimation as assessment with constant natural mortality is of very poor quality.

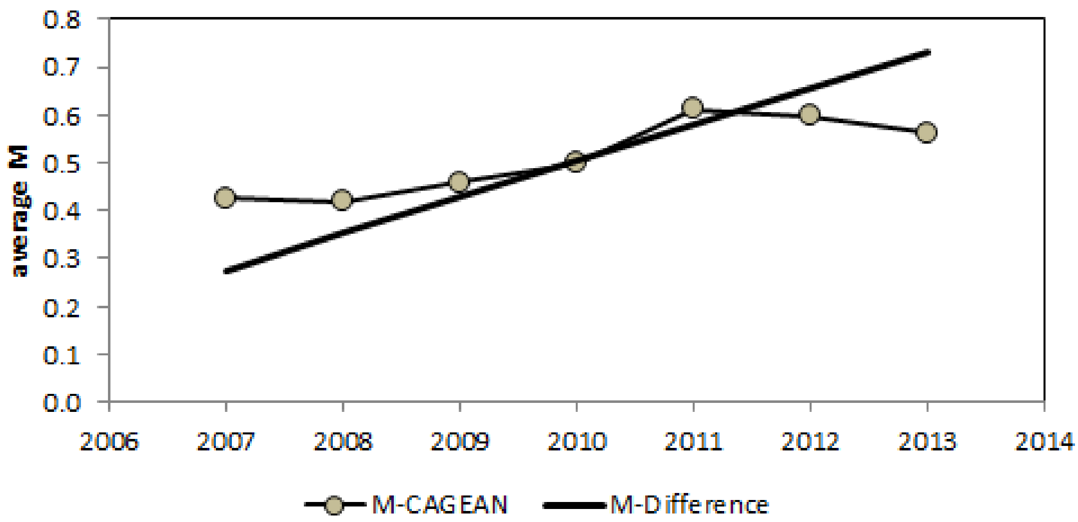

Figure 6. Comparison of the natural mortality estimates from the CAGEAN and difference production models (M is average for age 3 and older weighted by stock biomass at age).

The results of above simulations were presented at ICES workshop and benchmark assessment (WKSIBKA and WKBALCOD) and submitted for publication.

Data for assessment of herring and sprat stocks according to assessment units used up to early 1990s were compiled; these includes data for separate assessment of herring in sub-divisions 25-27 and 28.2-29+32 and sprat in sub-divisions 22-25, 26+28, and 27+29-32. In addition, data for separate assessment of Gulf of Finland herring were derived. Compiled data include catch and weight at age by sub-division, tuning data at age by fleet and sub-division, and natural mortality estimates by assessment unit.

The script in R was developed to perform above assessments by units applying XSA model; the XSA is accepted by ICES as basic assessment model for clupeids in the Baltic.

A few trial assessments of herring in Gulf of Finland (sub-division 32) and sub-divisions 28.2, 29, and 32 were performed. The methods used were XSA and SAM models. The assessments showed that fishing mortality in these stocks (assessment units) may be significantly higher than the F for presently used assessment unit of Central Baltic herring (CBH). The development of biomass and F in Gulf of Finland showed highest differences when compared to CBH dynamics. The persistent spatial and temporal differences in stock structure and in mean weights in particular can have a significant influence on the effects of the fishery in central Baltic waters (regulated as for CBH) on sub-stocks forming Central Baltic herring stock. The work is in initial phase, model parameterisation was a default one, so more work is required to get firm conclusions on herring dynamics by smaller assessment units.

Task 4.2 Stock identification of flounder in the Baltic Sea

The aim of this task is to develop tools to be used for estimation on allocation of catch to different spawning types of flounder in different fisheries in the Baltic Sea. In order to complete the first years sampled reference material of flounders with known spawning type, additional 125 flounders were sampled in WP1 and differentiated by egg and spermatozoa characteristics. The reference material has also been photographed for later morphometric analysis.

Genotyping continued with the previously developed protocol for a combination of 16 genetic microsatellites for 500 flounders sampled during gill survey including the reference collection.

Additionally, otoliths from 200 adults and 400 juveniles sampled in the WP1 surveys have been prepared and sent to subcontractor for advanced otolith micro-chemistry to differentiate between pelagic and demersal spawning flounder.

As the sampling within task 1.1 revealed the presence of spawning individuals of the coastal spawning flounder ecotype also at depth >65 m, indicating the potential for hybridisation between the flounder ecotypes, a cross-fertilization experiment with males and females from the respective ecotype was performed to assess viability of hybrid eggs/larvae. Samples of hatched larvae from the experiment have been forwarded within the project for genetic analysis. The reproductive success of hybrids vs non-hybrids has been evaluated by assessment of viable hatch and larval growth during the yolk sac stage.

Available data (earlier measurements and new measurement within the project; task 1.1) on egg specific gravity of flounder in different ICES SD have been complied to reveal potential differences in egg characteristics between spawning areas and they indicate the presence of sub-populations.

Results from the genetics, morphometrics and otolith chemistry analysis will be analyzed in year 3.

No deliverables or milestones within year two.

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

So far there is no accepted analytical assessment of flatfish stocks in the Baltic and ICES provides management advice on the basis of survey indices of stock size. Such advice is only approximate. The aim of this task is to provide analytical assessment or evaluation of the Baltic flatfish stocks, taking into account differentiation into populations (e.g. demersal and pelagic flounder) determined within Task 4.2. Depending on availability of data different approaches will be attempted for different stocks (e.g. catch curve analysis, stock-production models, length based models, age-structured models, random effect or Bayesian approaches).

Development of two of specific stock-production models in spreadsheet is in progress. One model is a difference model of Horbowy (1992) and the other is difference Schafer model in which demographic method to get estimate of intrinsic rate of increase (r) is used (McAllister et al., 2001)

In addition, some standard approaches like ASPIC and/or Collie & Sisenwine (1983) will be tested.

First Deliverable is scheduled for month 36 (D4.2 Database for flounder assessment or stock evaluation by stock).

3. Deviations from the workplan

There were no deviations from the workplan.

References

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WP 5 Ecosystem based management

Lead Meri Kallasvuo, P9 (LUKE)

1. Scientific highlights

The main idea here is to critically revise the existing management for Baltic cod, herring and sprat, by taking into account possible modifications and extensions when spatial heterogeneity is accounted for. The activitites taken so far include analyses and publications that support the overall goals of this work package and planning of the high-profile paper to be written as an end-result of INSPIRE project.

2. Summary

WP5 critically revises the existing management for Baltic cod, herring and sprat, taking into account possible modifications and extensions when spatial heterogeneity is accounted for. Modification may include changes in maximum sustainable yield due to different perception of predation mortality and recruitment. Extensions may include regionalization of management measures due to local extremes in exploited fish biomass. Furthermore, the implementation of the Marine Strategy framework Directive will be supported by linking MSFD indicators in a spatially explicit context.

Task 5.1. Importance of including spatio-temporal heterogeneity into stock assessments for ecosystem-based management

Results of assessments conducted in WPs 1 to 4 which take account of spatial effects, migrations, and stock structure will be applied here. So far the work is still ongoing in these workpackages. The idea in this task is to evaluate their influence on stock management and suggest alternative assessment approaches and/or assessment units. The activities in this task so far have consisted of studies of autumn herring reproduction failure that can be used as an indicator of reproductive potential of the stock. Visibly, abnormal ovaries were histologically characterized by irregular-shaped oocytes in a vitellogenic or final maturation stage with coagulative necrosis and liquefaction of the yolk sphere, degraded follicle membranes, and fibrinous adhesion among oocytes. Such degeneration is presumed to cause complete infertility in the fish. The frequency of fish with abnormal ovaries varied annually between 10 and 15% among all females sampled. However, specific sampling events showed up to 90% females with abnormal gonads. The specific cause of this abnormality remains unknown; however, prevalence was associated with unfavourable environmental conditions encountered before spawning: ovarian abnormality was positively related to water temperatures, with the highest level found at ≥15 degrees and negatively related to the frequency of strong winds (Ojaveer et al. 2015). Our investigations also show that herring spawning in spring and autumn in the Gulf of Riga are genetically highly differentiated. Differentiation was observed for three SNPs and for one transcriptome derived microsatellite marker, but clear population separation was only detectable with SNP markers, and neutral marker frequencies exhibited statistically non-significant differentiation among collections (Bekkevold et al. in press). These results are important in terms of spatial assessment and management of herring in the Baltic Sea, as they point to the need for separate assessment and management of these two herring ecotypes.

Development of an R script to test the effects of assumed stock structure (e.g. two former assessment units of herring in the central Baltic vs. presently used one unit) on stock management, and spatial and temporal data collection to build up a Bayesian network model which will provide information on potential causes in spatial and temporal fish distributions are ongoing actions.

Task 5.2. Importance of spatial heterogeneity in defining Baltic-specific MSFD indicators

Results from WPs 1 to 4 will be synthesized to MSFD indicators addressing descriptors, such as biodiversity, commercial species and food webs. The goal is the evaluation of different indicators across attributes into an overall assessment of GES. Work here will proceed as more knowledge is available from WPs 1-4.

Task 5.3 Regional management considerations

The activities taken so far include planning of the high-profile paper to be written as an end-result of BONUS INSPIRE project. The main idea is to bring new knowledge relevant to ecosystem-based management, produced in WPs 1 to 3, and propose a new way to include this knowledge into the current management routines and suggest modifications for improvement in management.

So far, there are clear indications that indicators for commercial fishing pressures cannot be derived for the whole eastern Baltic region based on the ICES assessment units. WP2 has shown that cod distribution is basically limited to the most southerly regions (ICES Sub-divisions 25 and 26), whereas herring and sprat are most concentrated in the northern areas. On the other hand, MSFD indicators are so far determined for the combined ICES Sub-divisions 25-32, while the Baltic Health index (BHI) is determined for 19 regions in the eastern Baltic which do not correspond to ICES sub-divisions or section hereof. Hence, GES and BHI will be biased if for example fishing pressure on cod is simply ‘copied’ to all regions. Here, BONUS INSPIRE will apply the knowledge on fish distributions to derive weighted indicator values, which do account for the fact that fisheries are limited to sub-regions.

3. Deviations from the worklan.

There were no deviations from the workplan.

References

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WP 6 Dissemination

Lead: Stefan Neuenfeldt, P2 (DTU-Aqua)

1. Highlights

By the close contact to various ICES expert groups and Baltic Sea Advisory Council, INSPIRE results have also during the second project year been made available to the stakeholders and interested public almost in real time. During the second year of the project, these activities continued substantially supporting the Eastern Baltic cod initiatives, and contributing to diverse ICES working groups with special focus on the ICES Workshop on Spatial Processes in the Baltic (WKSPATIAL) which has been started in close collaboration to INSPIRE. Two key results, namely that cod do not migrate a long distance to find better living conditions, and that decrease in condition already started during the 1980s, have been disseminated and will be an important building stone in re-formulating cod population and multispecies assessment models with significant contributions from INSPIRE.

Two joint events with other BONUS projects include: BIO-C3/BAMBI/INSPIRE Summer school "*The Baltic Sea: a model for the global future ocean?*" (Glücksburg, Germany, July 2015) and Theme Session on '*From genes to ecosystems: spatial heterogeneity and temporal dynamics of the Baltic Sea'* the ICES Annual Science Conference (Copenhagen, Denmark, September 2015).

Outside the ICES community, INSPIRE has been represented at several workshops and meetings. The overall goal in dissemination work here has been to show and apply the importance of spatial heterogeneity in the different activities.

The publishing activities have accelerated during the second year of the project as was to expect. INSPIRE has already produced 17 peer-reviewed papers and reports. These papers are listed on the project's web page and links to the abstracts are made available. The dissemination team is currently implementing the full-text availability, so that interested parties who do not have a licence for the respective version can receive postprint versions of the peer-reviewed manuscripts for free.

The INSPIRE web-site has been updated, linking now to peer-reviewed publicatons and meta-databases. On the BONUS web-site, young INSPIRE scientists share their experiences.

2. Summary

The WP aims to engage key target audiences downstream of the RTD core of the project, using a broad variety of engagement approaches:

1. Policy makers, by putting the latest research in policy-relevant context;
2. Non-specialist audiences, through effective use of press and medias;
3. Society at large, by providing full Open Access to projects research publications.

Scientists are criticized for poor communication of research to a non-scientific audience. The formats for communication that are respected in the scientific community (peer-reviewed publications and conference talks), are not appropriate to disseminate research to policy and decision makers. WP 6 will use a variety of proven non-technical communication means and methods to adapt the project's knowledge output to the evolving needs of the high-level end users through regular interaction with decision makers and to connect with the public through media, open access to research. This multi-faceted approach allows each target audience to be addressed in the most effective manner in order to best engage, exchange and inform.

Task 6.1 Participation at expert groups coordinates the consortium capacity to transfer the latest research into the "policy informing" domain, via consortium partners' participation in the relevant ICES expert groups, consultations via HELCOM and interaction with the relevant environmental stakeholders for the Baltic Sea Region. In total, INSPIRE sceintists have 102 participations at various stakeholder committees (Annex 1).

Also during the second year of INSPIRE, there has been a lot of attention to Eastern Baltic cod, because despite positive predictions, the analytical assessment was showing so large inconsistencies, that it could not be used or advice giving. This resulted in one of the most data dense stocks in the world have currently treated as being 'data-poor'.

First INSPIRE results were presented at the *ICES Workshop on Scoping for Integrated Baltic Cod Assessment* held in Gdynia, Poland, October 2014.

This work was continued during the *ICES Working Group on Baltic Fish Stock Assessments* held in Copenhagen, Denmark, April 2015, the ICES Working Group on Integrated Stock Assessments held in Cadiz, Spain, March 2015, the ICES Working Group on Multispecies Stock Assessments held in Woods Holes, USA, September 2015 and the ICES Workshop on Spatial Processes in the Baltic, held in Rome September 2015.

Further analyses of the stomach contents data from the EU tender together with analyses on cod condition were presented and the results, partially developed in close collaboration to BONUS BIO-C3 will be applied in developing the next generation of stock assessment models with strong representation of BONUS-generated scientific results.

Besides these 'hands-on' activities, the INSPIRE project and the BONUS framework were presented at several expert groups outside the ICES community:

1. A EU Strategy for the Baltic Sea Region (EUSBSR) event (Jurmala, Latvia June 2015);
2. The Baltic Sea Science Congress with several presentations from INSPIRE (Riga, Latvia June 2015);
3. Baltic Health Index workshop (Stockholm, Sweden, April 2015);
4. The 39th Annual Larval Fish Congress (Vienna, Switzerland, July 2015);
5. The European Marine Biology Symposium (Helgoland, Germany, September 2015);
6. Workshop on essential coastal habitats (Øregrund, Sweden, June 2015);
7. Larval herring workshop (Rostock, Germany, September 2015);
8. Coastal & Estuarine Research Federation (CERF), 23rd Biennial Conference, (Portland, USA, November 2015).

Task 6.2 Public awareness collaborates with the project research authors and ensure that 100% of the postprint versions of the projects` peer-reviewed manuscripts are accessible free of charge via EC FP7 Infrastructures OpenAIRE research repository (www.openaire.eu), boosting access to policy-relevant research, and increasing the visibility of the project and its publications authors. The benefits of Open Access are particularly important to PhD students, early career researchers, members of the interested public and scientists in developing countries. The first INSPIRE papers have now been published, and will be put into the repository during the next months. Work on the scheduled public science book, due in month 48, has not been started, yet. However, there are plans to present the major findings of INSPIRE in a children's book, with a facts part for the adults.

The following advisory-related activites started in 2014, were continued in 2015: review of the ICES management options on Baltic Sea fish stocks for 2016 in order to advice the European Commission implementing the EU Common Fisheries Policy; analysis of effort allocation in European fisheries in the Baltic Sea in order to advice the European Commission implementing the EU Common Fisheries Policy; advisory servicies for the Estonian Ministry of Environment on fisheries management options in the Baltic Sea (EU Common Fisheries Policy), and contribution to the national process of MSFD to propose monitoring scheme and developing program of measures (by **UT-EMI**); participation in national and international (BaltFish) meetings on fishing possibilities in the Baltic Sea; and participating in national discussions on the fishing possibilities in 2016, with distribution of the fishing effort in pelagic fisheries (by **BIOR**).

The following International scietific collaborations started in 2014, were continued in 2015: partnership within the global research network 'Oceans Past Initiative' (OPI, www.oceanspast.net); partnership with the EU COST Action 'Oceans Past Platform' (OPP), and participation in the global science initiative 'Indicators for the Seas (IndiSeas) (H. Ojaveer, **UT-EMI**); pan-Baltic regional study on the Baltic Health Index (BHI), by involving cooperation from outside the Baltic Sea - Ben Halpern and the Ocean Helth Index team (T. Blenckner **SU**, S.

Neuenfeldt **DTU-Aqua**, C. Möllmann **UHAM**, H. Ojaveer **UT-EMI**); membership of the LENFEST Fishery Ecosystem Task Force, led by Tim Essington and Phil Levin, to develop Ecosystem Management Plans for the US (C. Möllmann **UHAM**).

Blogs from INSPIRE young scientist can be found at:

http://www.bonusprojects.org/bonusprojects/blogs/inspire_me

and

http://www.bonusprojects.org/bonusprojects/blogs/data_cruncher/delicate_business_of_sharing_the_data.2586.blog

and

http://www.bonusprojects.org/bonusprojects/blogs/inspire(d)

In addition, INSPIRE has been performed several other national public outreach actvites. These are:

1. An Estonian national science event on international cooperation (Tallinn, Estonia, December 2015).
2. 'Open doors' event at the survey vessel Aranda (Finland, September 2015)
3. National radio interview by Michele Casini (Sveriges Radio, January 2016)
4. Local radio interview (Sweden, Radio Gotland, by Anders Nissling in April 2015)
5. Popular science paper in a national fishery journal (Estonia, by Henn Ojaveer)
6. Popular science paper in a national fishery journal (Finland, by Jari Raitaniemi and Jukka Pönni).

And finally, INSPIRE has made available 11 metadatasets at the project website. These provide information on the data used in all peer-reviewed papers published so far.

Task 6.3 Training school and concluding symposium conducts a summer school and a concluding symposium together with other, close related BONUS projects.

Under the overarching theme "The Baltic Sea: a model for the global future ocean?", and using an integrative approach, the BONUS BIO-C3/BAMBI/INSPIRE summer school, was organized by GEOMAR and held in Glücksburg, Germany, July 2015, addressing:

- Past, current & future environmental conditions in the marginal habitats of the Baltic Sea.
- Baltic biota under stress by exploitation, environmental fluctuations and global change
- Temporal and spatial trends in species invasions, community structure, biodiversity, and Baltic fish stocks.
- Stress physiology and the potential for evolutionary adaptation.

- The link from new fundamental science to informed resource management promoting sustainability.

From INSPIRE, lectures were given by Michele Casini (SLU), Christian Möllmann (UHAM), Andreas Lehmann (GEOMAR) and Anders Nissling (UU), while Anna Luzeńczyk (MIR-PIB), Alessandro Orio (SLU), Ivars Putnis (BIOR), Dorothee Moll (TI-OF) and Katharina Höflich (GEOMAR) attended the summer school as PhD students.

In addition to these scheduled activities, INSPIRE contributed to a Theme Session at the ICES Annual Science Conference 2015 in Copenhagen. Together with scientists from the other BONUS projects BIO-C3 and BAMBI, in the theme session considered new knowledge obtained on (1) biodiversity on all levels (e.g. genetic, species, community, habitat and functional), and its links to ecosystem features such as stability and functioning and (2) the spatial and temporal dynamics of species and communities.

For the upcoming ICES Annual Science conference 2016 in Riga, INSPIRE will co-chair a theme session on ‘The emerging science of ecological multi-model inference for informing fisheries management’ together with experts from NOAA, Seattle, USA. This session will explore the practical use of multi-model approaches in solving pressing management and policy issues, identify challenges in ecological multi-model inference, and aims to bring together marine scientists from different disciplines to discuss the development and application of multi-model inference in marine ecological and fisheries contexts. To this end, it represents a highly suitable forum to disseminate INSPIRE results and the BONUS framework and to strengthen collaboration with international experts.

3. Deviations from the worklan

BONUS BIO-C3/BAMBI/INSPIRE summer school, held in 2015, was not included in INSPIRE DoW. There were no other deviations from the workplan.

WP7 Management

Lead: Henn Ojaveer, P1 (UT-EMI)

1. Highlights

Efficient internal communication, systematic contacts with the BONUS Secretariat and continuous monitoring of the progress by the project coordination unit has secured timely science delivery according to the project workplan.

2. Summary

This WP has five generic objectives:

1. Ensuring that project objectives are achieved on time and within the costs estimated;
2. Co-ordinating all work conducted in the project,
3. Overseeing the task and work-packages,
4. Ensuring the development and production of deliverables, as well as reporting.
5. Ensuring that appropriate levels of communications are maintained among partners in order to achieve expected levels of scientific outputs.

The coordinator will carry out the day to day monitoring and management of the project, ensure co-ordination between the project partners and the circulation of project documents and data, and organize meetings and discussions. Work package leaders will keep the coordinator informed of the ongoing status of work packages. The co-ordinator will be responsible for communications with BONUS. The co-ordinator will organize the kick-off meeting, annual project meetings (incl., and invite and nominate scientists and stakeholder representatives to the advisory board. The co-ordinator will administer a budget for travel and subsistence costs for members of the Advisory Board to attend the project meetings and participate in the project. The co-ordinator will be responsible for financial and management reporting, as required by BONUS and defined in the workplan. The co-ordinator is also responsible for finalising all the reports, with input from work-package leaders. The final report will have broader dissemination and will circulate among partners prior to dissemination outside the consortium. The co-ordinator will make sure that the final report reflects a consensus of all partners. The co-ordinator will also take responsibility for ensuring that the project results are appropriately disseminated. The co-ordinator will be responsible for the organisation of a concluding symposium.

Task 7.1 Monitoring the project progress

This is a routine activity and achieved through contacts between the project coordinator and manager from one side and partner institute PI's, workpackage leads, fish champions and individual scientists from the other side.

Task 7.2 Internal communication

Project coordination unit (coordinator and manager) has been in a continous contact with partner institute PI's and individual scientists to ensure achieving project aims. This includes, amongst others, contacts with BONUS secretariat to enquire the relevant information needed for partner institutes on rules of operation, internal contacts within the project consortium to identify news items for the BONUS projects central website, INSPIRE project website and distribution of funds to partner institutes. Facilitation of preparing metadata sheets was ensured. Communication has been achieved via various means (physical meetings, e-mailing, Skype conferences, phone calls). Project Steering Committee meetings were arranged according to the plan (twice a year, both physical meetings: Hamburg, Germany on 10. February 2015; Charlottenlund, Denmark on 23. September 2015).

Task 7.3 Financial and management reporting

Multiple communication between the project coordination unit (coordinator and manager) and BONUS Secretariat has occurred to obtain information. The obtained information was synthesised and transferred to INSPIRE partner institute PI's and administrative contacts to ensure meeting BONUS needs for reporting. The first year activity report and cost statements have been approved by secretariat.

Task 7.4 Project meetings

Project coordinator unit (coordinator and manager) organised INSPIRE 2nd integrating workshop (Hamburg, 11-13. February 2015), INSPIRE 3rd integrating workshop (Charlottenlund Denmark, 25. September 2015) and annual meeting (Hamburg, 10-11. February 2015). Deliverables related to the integrating workshops were submitted according to SoD. The annual meeting report can be found in Annex 2.

Task 7.5 Administration of the Advisory Board

Advisory Board (AB) member Pehr Eriksson, representing the Baltic Sea Advisory Council, has been invited to all integrating workshops and to project Annal meeting. All reports with status 'public', incl. kick-off report, annual meeting report and integrating workshop reports were e-mailed to AB members and asked for comments and feedback. Also, physical meeting between AB members and project coordinator and PI from DTU-Aqua was held in conjuction of the ICES ASC 2015. It was agreed (at the 4th SC meeting) to adopt the 'targeted approach' for getting more efficient feedback from AB members: each advisory board member will have one or more INSPIRE PI and/or fish champion as a primary contact. The identified INSPIRE contacts have responsibility to initiate discussions and ask for specific advice/feedback on important issues.

3. Deviations from the worklan

There were no other deviations from the workplan than the 3rd Integrating workshop, originally scheduled to M18, was held on M20 to allow INSPIRE scientists to present their work at the BONUS theme session during the ICES ASC 2015.

3. Promoting an effective science-policy interface to ensure optimal take up of research results

INSPIRE strategy is to ensure efficient and timely two-directional communication with stakeholders. In this regard, communication and cooperation with Baltic Sea Advisory Commission (BSAC) and International Council for the Exploration of the Sea (ICES) is our priority. BSAC representative (Pehr Eriksson) is involved in scientific discussions in INSPIRE and is regularly attending project annual meetings and integrating workshops. In total, INSPIRE scientists had 102 participations in local, national and international stakeholder committees (Annex 2) with the dominating role in fisheries and ecosystem-oriented groups in ICES. In addition, several scientists are performing advisory role at national and international levels (incl. in relation to EU Common Fisheries Policy, EU Marine Strategy Framework Directive and Multiannual management of Baltic fish stocks). However, it is noted here, that we were not always successful in communicating effectively our new research results to appropriate stakeholders in an appropriate time-frame. Therefore, it is suggested here for BONUS to act centrally and if possible, organise generic stakeholder events.

4. Collaboration with relevant research programmes and the science communities in the other European sea basins and on international level

Several project partners are involved in international collaboration beyond the Baltic Sea. The nature and framework of the collaboration is varying and spanning from formal long-standing global international reserach networks (such as ‘Oceans Past Initiative’ and ’Indicators for the Seas’) to more regional and narrower activities (US LENFEST Fishery Ecosystem Task Force) and attendances of workshops focussing on modeling of ecological systems and performing ecosystem assessments. Strong collaboration in several ICES expert groups has been established and it forms backbone for some of the ecosystem-related research in INSPIRE.

5. Progress in comparison with the original research and financial plan, and the schedule of deliverables

The project is progressing according to the research plan without any deviations affecting achieving its aims and goals. Seven deliverables sceduled to year #2 (D1.1, D2.2, D2.3, D2.4; D7.2, D7.3, D7.4) were submitted according to SoD. Minor modifications in the original financial plan have occurred in several partner institutes without implications to the workplan and science delivery. Further changes in financial plan for several partner institues are to be expected, due to shift of the INSPIRE training school from 2017 to 2016, and to be held jointly with other relevant BONUS projects (see below).

6. Amendments to the description of work and schedule of deliverables

No changes to the description of work has neither occurred nor expected in coming years. However, there are few changes (please see details below) in milestone/deliverables, which all were approved by the BONUS secretariat. These changes were driven from the motivation to increase efficiency of the science in the project in altered external conditions, will not affect planned science delivery, but will increase visibility and impact of the project results.

i) Join BONUS BIO-C3 project for the joint BIO-C3/BAMBI/INSPIRE Summer school with both lecturers and early career scientists from INSPIRE project to attend the event. Participating in this summer school was not included into to workplan of INSPIRE.

ii) Arrange the 3rd Integrating workshop (originally scheduled to M18) on M20 (to allow INSPIRE scientists to present their work at the BONUS theme session during the ICES ASC). This request was approved by the BONUS Secretariat;

iii) Shift timing of the second annual meeting from M27 (April 2016) to M32 (September 2016), to be held it in conjunction with ICES ASC (Riga, Latvia), in order to be able to reflect on the first iteration of assessment work. This request was approved by the BONUS Secretariat.

iv) Shift timing of INSPIRE Training school from 2017 to 2016, and to held it together with other relevant BONUS projects (Denmark, August 2016). This request was approved by the BONUS Secretariat.

7. Performance statistics

The information below is given by project partners for the first project years by using institional short names as indicated on page 4 above.

1. **Number of times the project has contributed significantly to the development and implementation of 'fit-to-purpose' regulations, policies and management practices on international, European, the Baltic Sea region or national level aimed at safeguarding the sustainable use of ecosystem's goods and services.**

2014

UT-EMI

Review of the ICES management options on Baltic Sea fish stocks for 2015 in order to advice the European Commission implementing the EU Common Fisheries Policy (2014-06_STECF 14-10 - BALTIC ADVICE for 2015_JRC90504.pdf)

Analysis of effort allocation in European fisheries in the Baltic Sea in order to advice the European Commission implementing the EU Common Fisheries Policy (STECF 2014-12 Evaluation of Fishing Effort Regimes - p2_JRC93183.pdf)

Advisory servicies for the Estonian Ministry of Environment on fisheries management options in the Baltic Sea (EU Common Fisheries Policy).

Contribution to the national process of MSFD to propose monitoring scheme and start to develop program of measures.

BIOR
Participation in national and international (BaltFish) meetings on fishing possibilities in the Baltic Sea. Important component of these meeting have been proposing management options of fishing effort distribution in the Baltic Sea in pelagic fisheries that is closely connected with the INSPIRE objective to elaborate a spatially explicit advice for ecosystem-based fisheries management.

MIR-PIB
Attendance of the meeting at EC discussing the Multiannual plan for the Baltic Sea fisheries (by Jan Horbowy).

2015
DTU-Aqua
Advisory services for the Danish Ministry of Environment, Agriculture and Fisheries on fisheries options in the Blatic Sea with spoecial focus on cod fisheries and the Common Fisheries Policy.

MIR-PIB
Formulating management advice of the Baltic fish stocks to ICES, and providing evidences of increasing natural mortality of cod.

Providing advice services to Polish Ministry responsible for fisheries on stock management, incl. reporting on indicators of balance between fishing capacity and fishing opportunities.

SLU
Contribution to HELCOM for the development of indicators of the state of offshore fish community and for the HOLAS II project.

Advisory services for the Swedish Agency for Marine and Water Management on fisheries management options in the Baltic Sea with special focus on cod fisheries and the Common Fisheries Policy.

2. **Number of suggestions for designing, implementing and evaluating the efficacy of relevant public policies and governance on international, European, the Baltic Sea region or national level originating from the work of the project.**

2014
BIOR

National discussion on the fishing possibilities in 2015, distribution of the fishing effort in pelagic fisheries.

2015
DTU-Aqua

National discussions and suggestions on limiting sprat fisheries in ICES SD 25 in order to increase living conditions for cod.

MIR-PIB

National discussions at the Department of Fisheries on developing measures to improve cod stock and fisheries in the Baltic Sea.

3. **Number of times the scientists working in the project have served as members or observers in stakeholder committees.**

INSPIRE scientists have in total 102 participations in stakeholder committees in 2015 (for details, please see Annex 2).

4. **Number of international, national and regional stakeholder events organised by the project** (include information about number of participants and kinds of sectors represented)

2014
None

2015
LUKE

Open doors at survey vessel RV Aranda 09/2015. The scientists from Luke presented fisheries research and stock assessment work to media and public. 900 participants.

5. **Number of joint events/co-operation activities/partnerships of the project with non-Baltic research actors and other European marine basins**.

2014

UT-EMI

Partnership within the global research network ‘Oceans Past Initiative’ (OPI, www.oceanspast.net) and the EU COST Action ‘Oceans Past Platform’ (OPP).

Participation in the global science initiative ’Indicators for the Seas, (IndiSeas).

DTU-AQUA

Participation in the the 3rd NMFS National Ecosystem Modeling Workshop held by NOAA in Seattle, WA, USA. The workshop was focused on ensemble modelling of ecological systems, and Stefan Neuenfeldt was invited to present some of the INSPIRE concepts to NOAA scientists.

Particiaption in Knowledge Based Bio-Economy (KBBE) workshop on MICE models, multispecies models, and harvest strategies for lowinformation stocks in Wellington, NZ. The workshop was focused on Models of Intermediate Complexity for Ecosystem assessments, and Stefan Neuenfeldt was invited to present the modelling strategy in INSPIRE in relation to identification of potential target levels for Central Baltic Sea fishing mortalities taking species interactions and spatial overlap into account.

SU

Pan-Baltic regional study on the Baltic Health Index (BHI), scientifically led by Thorsten Blenckner was initiated, where INSPIRE is also expected to contribute. It involves also cooperation from outside the Baltic Sea - Ben Halpern and the Ocean Helth Index team.

UHAM

Christian Möllmann is member of and has participated in 2 meetings of the LENFEST Fishery Ecosystem Task Force lead by Tim Essington and Phil Levin. The Task Force develops Ecosystem Management Plans for the US. Christian Möllmann is the selected European expert.

UU

Co-operation with Pedro Morais, Portugal in a planned pan-European project „Causes and mechanisms explaining fish life history plasticity“ focusing on flounder. Otoliths (for trace element analysis) and tissue samples (genetical analysis) from flounder from the Baltic will be included in the comparison.

2015

TI-OF

Workshop on larval herring ecology in Greifswald Bay to establish cooperation with Canadian scientists (Université Laval Département de biologie). Thuenen-Institute of Baltic Sea Fisheries 20-24. August 2015 (12 participants).

UU

Incolved in a U.S. National Science Fundation project concerning effects of hypoxia on growth in fish; including fish from the Gulf of Mexico, Great Lakes and the Baltic Sea. From the Baltic, microchemistry analysis of otoliths from cod and flounder are used to identify whether indivuduals have been subjected to low oxygen concentration or not.

6. **Number of persons (1) and working days (2) spent by foreign scientists on research vessels** participating in the cruises arranged by the project.

2014
None

2015
DTU-Aqua
At the combined INSPIRE/BIO-C3 research cruise in the Bornholm Basin (ICES SD 25), DTU-Aqua hosted 1 research scientist from GEOMAR (PhD Cornelia Jaspers, and one from IOW (PhD Jörg Dutz), Warnemünde. The 15 days cruise took place in September 2015

UHAM
Research cruise on RV Alkor in the Bornholm Basin in April 2015. UHAM hosted 1 research scientist from DTU-Aqua (Stefan Neuenfeldt) for two days cruise.

7. **Number of persons and working days spent by foreign scientists using other major research facilities involved in the project**.

2014
None

2015
LU
Post-doc Mikael van Deurs from DTU-AQUA Denmark has used laboratory facilities at LU, working on cod biology 365 days.

UU
PhD Melvin Samson, SUNY-ESF U.S. stayed at the Ar Research Station, Uppsala university for preparation of flounder otoliths within the U.S. National Science Fundation project concerning effects of hypoxi on growth in fish 12 days.

8. **Number of peer-reviewed publications arising from the project research with authors from, at least, two different participating states**.

2014
None

2015
UT-EMI
Ojaveer, H., Tomkiewicz, J., Arula, T., Klais., R. (2015). Female ovarian abnormalities and reproductive failure of autumn-spawning herring (*Clupea*

harengus membras) in the Baltic Sea. ICES Journal of Marine Science. 72(8), 2332–2340

DTU-AQUA

Eero, M., Hjelm, J., Behrens, J., Buchmann, K., Cardinale, M., Casini, M., Gasyukov, P., Holmgren, N., Horbowy, J., Hüssy, K., Kirkegaard, E., Kornilovs, G., Krumme, U., Köster, F. W., Oeberst, R., Plikshs, M., Radtke, K., Raid, T., Schmidt, J., Tomczak, M. T., Vinther, M., Zimmermann, C., Storr-Paulsen, M. 2015. Eastern Baltic cod in distress: biological changes and challenges for stock assessment. ICES Journal of Marine Science, http://icesjms.oxfordjournals.org/content/72/8/2180

Hüssy, K., Hinrichsen, H. H., Eero, M., Mosegaard, H., Hemmer-Hansen, J., Lehmann, A. and Lundgaard, L. S. (2015) Spatio-temporal trends in stock mixing of eastern and western Baltic cod in the Arkona Basin and the implications for recruitment ICES Journal of Marine Science . fsv227. DOI 10.1093/icesjms/fsv227.

Hüssy, K., Gröger, J., Heidemann, F., Hinrichsen, H.-H., and Marohn, L. 2015. Slave to the rhythm: seasonal signals in otolith microchemistry reveal age of eastern Baltic cod (*Gadus morhua*). ICES Journal of Marine Science, http://icesjms.oxfordjournals.org/content/early/2015/12/18/icesjms.fsv247

BIOR

Ustups, D., Bergström, U., Florin, A.B., Kruze, E., Zilniece, D., Elferts, D., Knospina, E. & Uzars, D. 2016. Diet overlap between juvenile flatfish and the invasive round goby in the central Baltic Sea. J. Sea Res. 107, pp. 121-129

GEOMAR

H.-H. Hinrichsen, A. Lehmann, C. Petereit, A. Nissling, D. Ustups, U. Bergström, K. Hüssy. 2016. Spawning areas of eastern Baltic cod revisited: Using hydrodynamic modelling to reveal spawning habitat suitability, egg survival probability, and connectivity patterns. Progress in Oceanography. http://dx.doi.org/10.1016/j.pocean.2016.02.004

Hinrichsen H.-H, von Dewitz B, Dierking J, Haslob H, Makarchouk A, Petereit C, Voss R. 2016 Oxygen depletion in coastal seas and the effective spawning stock biomass of an exploited fish species. R. Soc. open sci. 3: 150338. http://dx.doi.org/10.1098/rsos.150338

9. Number of entries to existing openly accessible common databases, storing original data from the entire Baltic Sea system or larger geographical area.

2014
UT-EMI

Entry of the Gulf of Riga larval herring data (2004-2013) into ICES ichtyoplankton database.

Assembling pan-Baltic zooplantkon database (joint activity with BIO-C3; see http://kodu.ut.ee/~riina82/index.html). The metadatabase is under preparation and will be uploaded to the website as soon as ready.

MIR-PIB
Multiple data entries to BITS database.
Multiple data entries to INTERCATCH database.

LUKE
Entry of data into Baltic International Fish Survey (BIFS) and BITS databases.

2015
UT-EMI

Entry of data to pan-Baltic zooplantkon database (together with BIOR and MIR-PIB; this is a joint activity with BONUS BIO-C3; http://kodu.ut.ee/~riina82/index.html).

DTU-Aqua
Entry of stomach content data in the ICES database (together with SLU).

MIR-PIB
Entry of BITS data to DATRAS database (together with BIOR, SLU, DTU-Aqua, UT-EMI and LUKE).

SLU
Contribution of BIAS and BAS data to BAD database (together with DTU-Aqua, BIOR, MIR-PIB, UT-EMI and LUKE).

TI-OF
Entry of the Rügen larval herring data (1992-2015) into the ICES ichtyoplankton database.

LUKE
Entry of data to ICES INTERCATCH database (together with BIOR, DTU-Aqua, SLU, MIR-PIB and UT-EMI).

10. Number of popular science papers produced by the project.

2014
None

2015
UT-EMI
Ojaveer, H. 2015. Sprat. In: Kalastaja, pg. 112 (national fishery journal).

LUKE

Jari Raitaniemi and Jukka Pönni 2015. Torsken återhämtar sig. Fiskarposten no 9, pp. 4. (in Swedish; popular article in Finnish national fisheries newspaper ’Fiskarposten’ about Baltic fish stocks).

11. **Number of interviews to media** given by the members of the project's consortium.

2014

MIR-PIB

Interview to Polish TV by Jan Horbovy (September 2014).

SLU

Michele Casini, phone interview, 16-09-2014. Radio Germany: Current Research, “Fishery-induced changes in fish population structure, with Baltic Sea focus”.

Ann-Britt Florin, 10-05-2014, Gotlands Allehanda – local Swedish newspaper, ”Fiskar efter svar om östersjöns arter” (Fishing after answers about Baltic species).

UU

Anders Nissling, local radio (Radio Gotland), Sweden, January 2015 (topic: saline water inflow & potential effects on fish stocks).

2015

SLU

Michele Casini, radio interview, 22-01-2016. Sveriges Radio, P4 Blekinge: “Miljonsatsning ska kartlägga torsken i Östersjön” (”Million effort to map cod in the Baltic Sea”).

UU

Anders Nissling, local radio (Radio Gotland), Sweden, April 2015 (topic: flounder ecology; life-history strategy of the respective flounder ecotype).

12. **Number of multi-media products and TV episodes produced by the project with dissemination purpose**.

2014

None

2015

None

13. Number of other international, national and regional communication, dissemination and public outreach initiatives to disseminate the project's research results.

2014

UT-EMI

Ojaveer, H. 2014. BONUS INSPIRE: Integrating spatial processes into ecosystem models for sustainable utilization of fish resources. Written communication to HELCOM FISH-ENV 10-2014.

Ojaveer, H. et al. 2014. Integrating spatial processes into ecosystem models for sustainable utilization of fish resources. Poster presentation at ICES ASC.

Ojaveer, H. 2014. Integrating spatial processes into ecosystem models for sustainable utilisation of fish resources. Baltic Maritime Spatial Planning Forum. 17-18. June 2014, Riga, Latvia.

Arula, T., Ojaveer, H. 2014. Can we predict Baltic spring spawning herring *Clupea harengus membras* recruitment form larval abundance? EU FP7 project VECTORS Final Meeting in La Grande Motte (France) in 17-21 November 2014. Poster presentation.

2015

UT-EMI

Arula, T., Laur, K., Simm, M. and Ojaveer, H. 2015. Dual impact of temperature on growth and mortality of marine fish larvae in a shallow estuarine habitat. Estuarine, Coastal and Shelf Science, http://dx.doi.org/10.1016/j.ecss.2015.10.004

Arula, T., Raid, T., Simm, M., Ojaveer, H. 2015. Temperature-driven changes in early life-history stages influence the Gulf of Riga spring spawning herring (*Clupea harengus* m.) recruitment abundance. Hydrobiologia. doi:10.1007/s10750-015-2486-8.

Raid, T., Arula, T., Kaljuste, O., Sepp, E., Järv, L., Hallang, A., Shpilev, H., Lankov, A. 2015. Dynamics of the commercial fishery in the Baltic Sea: What are the driving forces? In: Towards Green Marine Technology and Transport – Guedes Soares, Dejhalla & Pavleti (Eds). Taylor & Francis Group, London

Arula, T., Ojaveer, H., Raid, T. Mortality and growth at larval stage: advancing the understanding of stock dynamics processes in the Gulf of Riga spring spawning herring (Clupea harengus membras). 10th Baltic Sea Science Congress, 15-19 June 2015, Riga, Latvia.

Arula, T., Raid, T., Simm, M. and Ojaveer, H. Factors affecting the abundance of spring spawning herring (*Clupea harengus membras*) larvae in the Gulf of Riga. ICES ASC (Copenhagen, Denmark 21-25. September 2015).

Arula, T., Raid, T., Simm, M., Ojaveer, H. Importance of plankton seasonality on larval herring and year-class abundance of the Gulf of Riga spring spawning herring (Clupea harengus m.). 39th Annual Larval Fish Conference. Vienna, Austria; 12-17. July 2015.

Klais, R., Lehtiniemi, M., Teder, M., Rubene, G., Semenova, A., Margonski, P., Ikauniece, A., Simm, M., Põllumäe, A., Griniene, E., Mäkinen, K. and Ojaveer, H. 2015 Spatiotemporal variability of the Baltic Sea mesozooplankton. ICES WKSPATIAL (Rome, Italy, 3-6. Nov. 2105).

Klais, R., Lehtiniemi, M., Teder, M., Rubene, G., Semenova, A., Margonski, P., Ikauniece, A., Simm, M., Põllumäe, A., and Ojaveer, H. 2015 Spatial and temporal variability of mesozooplankton in the Baltic Sea. ICES ASC (Copenhagen, Denmark 21-25. September 2015).

Ojaveer, H. Moderating panel discussion exploring how the BONUS, PRIMA and JPI Oceans initiatives can cooperate and contribute to the Horizon 2020 marine research priorities in the areas of Blue Economy and Resource Efficiency. Cooperation in Marine Science around the Baltic Sea and beyond: a contribution to Europe’s Societal Challenges. Event organised by Estoanian Research Council. Brussels, **B**elgium, 22. April 2015.

Ojaveer, H. What kind of shift your project will bring to scientific basis of fisheries management? BONUS projects’ kick-off meeting, triple meeting and a BONUS information event for the European community, Brussels, 1-2 December 2015.

Ojaveer, H. 2015. Representing INSPIRE project at a panel session discussion on ’Science and knowledge’ of the Annual Forum of the EU Strategy for the Baltic Sea Region, 16 June 2015, Jurmala.

Ojaveer, H. BONUS projects INSPIRE and BIO-C3. Conference about international cooperation. Tallinn, Estonia, 3. December 2015.

Ojaveer, H., Teder, M., Simm, M., Raid, T. and Klais, R. 2015. Feeding ecology of pelagic fish in the Gulf of Riga. ICES WKSPATIAL (Rome, Italy, 3-6. Nov. 2105).

Raid, T., Arula, T., Kaljuste, O., Sepp, E., Järv, L., Hallang, A., Shpilev, H., Lankov, A. Dynamics of the commercial fishery in the Baltic Sea: What are the driving forces? 16th Congress of the Maritime Association of the Mediterranean, IMAM, 21-24 September 2015, Pula, Croatia.

DTU-Aqua

Bekkevold, D., Gross, R., Arula, T. and Ojaveer, H. 2015. Spring and autumn spawning herring in the Gulf of Riga: intraspecific biodiversity across small local scales. Presentation at ICES ASC (Copenhagen, Denmark 21-25. September 2015).

Karin Hüssy, Henrik Mosegaard, Christoffer, Moesgaard Albertsen, Jakob Hemmer-Hansen, Margit Eero. 2015. Stock mixing of eastern and western

Baltic cod in SD 24. Presentation at ICES ASC (Copenhagen, Denmark 21-25. September 2015).

Margit Eero, Helén Andersson, Elin Almroth Rosell, Brian R. MacKenzie. 2015. Has human-induced eutrophication promoted fish production in the Baltic Sea? Presentation at ICES ASC (Copenhagen, Denmark 21-25. September 2015).

Ojaveer, H., Tomkiewicz, J., Arula, T. and Klais, R. Female ovarian abnormalities and reproductive failure of autumn spawning herring (*Clupea harengus membras*) in the Baltic Sea. ICES ASC (Copenhagen, Denmark 21-25. September 2015).

Stefan Neuenfeldt, Christian Möllmann 2015. Net displacement and time at large: Adult migrations probably do not contribute to whole Baltic scale redistribution of cod (Gadus morhua L.). Presentation at ICES ASC (Copenhagen, Denmark 21-25. September 2015).

Stefan Neuenfeldt, 2015. Eastern Baltic cod consumption and energy uptake decreased. Presentation at ICES WGSAM (Woods Hole, USA, via skype, September 2015).

Stefan Neuenfeldt, 2015. Eastern Baltic cod prey dependent growth. Presentation and ICES WKSPATIAL (Rome, USA, Italy, September 2015).

MIR-PIB

Horbowy, J., Podolska, M. 2015. Does parasitic infection effect natural mortality of cod? Working document for ICES WKBALCOD [in: ICES. 2015. Report of the Benchmark Workshop on Baltic Cod Stocks, 2–6 March 2015, Rostock, Germany. ICES CM 2015/ACOM:35].

Horbowy, J., Luzeńczyk, A. 2015. Cod in the eastern Baltic - assessment with stock-production models. Working document for ICES WKBALCOD [in: ICES. 2015. Report of the Benchmark Workshop on Baltic Cod Stocks, 2–6 March 2015, Rostock, Germany. ICES CM 2015/ACOM:35].

Horbowy, J., Podolska, M., Nadolna-Ałtyn, K. 2016. Increasing occurrence of anisakid nematodes in the liver of cod (Gadusmorhua) from the Baltic Sea: Does infection affect the condition andmortality of fish? Fisheries Research 179: 98–103. http://dx.doi.org/10.1016/j.fishres.2016.02.011

SU

Thorsten Blenckner, Viktorsson, L., Schewenius, M., Elwing, T. Rockström, J., Halpern, B. 2015. Assessing the ocean health of the Baltic Sea. Presentation at ICES ASC (Copenhagen, Denmark 21-25. September 2015).

Meeting with Her Royal Highness Crown Princess Victoria from Sweden to present the ongoing work on the Baltic Sea ecology and management (23. Sepember 2015).

SLU

Casini, M., Käll, F., Hjelm, J. 2015. Changes in the body condition of the Eastern Baltic cod - potential explanations. Working document for ICES WKBALTCOD [in: ICES. 2015. Report of the Benchmark Workshop on Baltic Cod Stocks, 2–6 March 2015, Rostock, Germany. ICES CM 2015/ACOM:35]

Orio, A. 2105. Understanding the spatio-temporal dynamics of demersal fish species in the Baltic Sea. Aqua Introductory Research Essay 2015:1 Department of Aquatic Resources. Swedish University of Agricultural Sciences, Drottningholm Lysekil Öregrund. 29 p. http://pub.epsilon.slu.se/12864/7/orio_a_151126.pdf.

Casini, M. Käll, F., Hansson, M. And Hjelm, J. 2015. Dead zones relate to the body condition of the Baltic Sea cod. Oral presentation at the "ICES Annual Science Conference", Copenhagen (Denmark), 21-25 September 2015.

Alerssandro Orio and Michele Casini 2015. Modelling the spatio-temporal dynamics of cod and flounder in the Baltic Sea using bottom trawl surveys data. Presentation at ICES ASC (Copenhagen, Denmark 21-25. September 2015).

Casini, M. "Spatio-temporal changes in exploited fish populations in the Baltic Sea: patterns, causes and consequences". Oral presentation at the Annual Congress of the Swedish Society of Marine Sciences, Lund (Sweden), 18-20 November 2015. Key-note speaker.

Organising workshop on Essential Coastal Habitats (SLU, Öregrund, Sweden, 2-4 June 2015).

BIOR

Makarchouk, A. and Arula, T. 2015. Changes in spation-temporal distribution of eggs and larvae of sprat (Sprattus sprattus) in the Gotland Basin (Baltic Sea) in 2004-2014. ICES CM 2015/Q:16. Presentation at ICES ASC (Copenhagen, Denmark 21-25. September 2015).

Briekmane L., Ustups D., Berzins V. and Plikshs M. 2015. Changes in fish communities in the coastal area of Baltic Sea and Gulf of Riga during last decade. ICES CM 2015/Q:32 Presentation at ICES ASC (Copenhagen, Denmark 21-25. September 2015).

TI-OF

Moll Dorothee; Kotterba Paul; Polte Patrick 2015. Spawning bed selection of Atlantic herring (*Clupea harengus*) in coastal waters of the Western Baltic Sea. Presentation at 39th Annual Larval Fish Conference. Vienna, Austria, 12-17. July 2015.

Moll Dorothee; Kotterba Paul; Polte Patrick 2015. Spawning bed selection of Atlantic herring in coastal waters of the Western Baltic Sea. Presentation at

European Marine Biology Symposium, 21.-25. September 2015. Helgoland, Germany.

Polte, Patrick, Paul Kotterba, Julia Heiler, Sarah Beyer, Dorothee Moll, Lena v. Nordheim 2015. Loops of near shore habitat use by early herring (*Clupea harengus*) life stages in the Western Baltic Sea. Presentation at ICES ASC (Copenhagen, Denmark 21-25. September 2015).

Polte, Patrick, Paul Kotterba, Dorothee Moll, Lena v. Nordheim 2015 Drivers and stressors of Atlantic herring (*Clupea harengus*) recruitment in inshore Baltic Sea spawning areas. Presentation at CERF 2015, Grand Challenges in Coastal & Estuarine Science: Securing Our Future, Portland, Oregon, USA, 8.-12- November.

Paulsen Matthias; Clemmesen Catriona; Hammer Cornelius; Malzahn Arne; Patrick Polte; Peck Myron. 2015. Investigating nutritional effects on growth rates of larval herring in the vestern Baltic Sea**.** Presentation at 39th Annual Larval Fish Conference. Vienna, Austria; 12-17. July 2015.

LUKE

STOCK DIVERSITY OF HERRING IN THE NORTHERN BALTIC: IS THE SEPARATE ASSESSMENT OF THE HERRING IN THE GULF OF FINLAND POSSIBLE? Tiit Raid Jukka Pönni and Jari Raitaniemi Gulf of Finland Trilateral Co-operation Scientific Forum, 17-18 November 2015, Tallinn, Estonia.

PELAGIC FISH STOCKS IN THE GULF OF FINLAND - LIFE ON THE EDGE OF THE SEA Heikki Peltonen, Tiit Raid and Jukka Pönni Gulf of Finland Trilateral Co-operation Scientific Forum, 17-18 November 2015, Tallinn, Estonia.

Participating at international/regional communication: trilateral cooperation Finland-Estonia-Russia / Gulf of Finland studies.

GEOMAR

Andreas Lehmann, Hans-Harald Hinrichsen, Katharina Höflich. 2015. Spawning areas of eastern Baltic cod revisited: Using hydrodynamic modeling to identify hotspots. Presentation at ICES ASC (Copenhagen, Denmark 21-25. September 2015).

Katharina Höflich, Andreas Lehmann, Piia Post, Klaus Getzlaff and Kai Myrberg. 2015. On the atmospheric and oceanic conditions associated with large volume changes (LVCs) and major inflows (MBIs) to the Baltic Sea. Presentations at BSSC (Riga, Latv15-19 June 2015).

LU

Anders Persson, Peter Ljungberg, Anders Nilsson. 2015. Predicting spatial and temporal use of coastal habitats by Atlantic cod using foraging theory. Presentation at ICES ASC (Copenhagen, Denmark 21-25. September 2015).

UU

Wallin, Isa 2016. Opportunities for hybridization between two sympatric flounder (*Platichtys flesus*) ecotypes in the Baltic Sea. Master thesis in biology, Biology Education Centre, Uppsala university (supervisor Anders Nissling).

Nyberg, Sofia 2015. Egg buoyancy and survival probabilities of the Baltic flounder (*Platichtys flesus*); differences between spawning areas and interannual variation in conditions for reproduction. Bachelor thesis in biology, Biology Education Centre, Uppsala university (supervisor Anders Nissling; assistant supervisor Christoph Petereit).

14. Number of post graduate courses organised by the project (1) and persons participating (2).

2014
None

2015
None

15. Number of mobility activities – persons (1), visit days (2) – From the project to the other BONUS projects.

2014

UT-EMI

Participation in BONUS BIO-C3 work: meetings and initiation of joint activities: Baltic Sea zooplankton study (http://kodu.ut.ee/~riina82/) and BONUS Theme Session at ICES ASC 2015 (http://www.ices.dk/news-and-events/asc/ASC2015/Pages/Theme-Sessions.aspx).

MIR-PIB

Participation (A. Luzeńczyk) at BIO-C3 kick-off meeting.

UU

Anders Nissling participated on a survey with R/V Alkor & provided Jan Dierking (BIO-C3) with flounder samples for isotope analysis.

2015

UT-EMI

Attendance (H. Ojaveer) at BONUS BIO-C3 annual meeting in Kiel, Germany; 30. June – 3. July 2015 (4 days).

Working visit (7 days) of H. Ojaveer to DTU-AQUA for collaboration with BONUS BIO-C3.

DTU-Aqua

S. Neuenfeldt visited UHAM 2 times á 2 days to coordinate with BONUS BIO-C3 participants.

UU

Sofia Nyberg participated on a survey with R/V Alkor (BIO-C3) (time spent 15 days) sampling flounder for determination of ecotype & performed measurements of egg specific gravity.

16. **Number of PhD students (1) and the number of post-docs (2) funded by the project** as well as the number of **doctoral thesis defended (3)**.

2014

SU

One post doc (Susa Niiranen) started in SU in 2014**.**

SLU

One PhD student (Alessandro Orio) started in SLU in 2014.

BIOR

One PhD student (Ivars Putnis) is a part-time participant and one Post doc (Didzis Ustups) started in INSPIRE project.

TI-OF

One PhD student (Dorothee Moll) started in TI-OF in 2014.

UHAM

One Post doc (Klas Ove Möller) and one PhD student (Muriel Kroll) started in UHAM in 2014.

GEOMAR

One PhD student (Katharina Höflich) started in GEOMAR in 2014

2015

MIR-PIB

Two PhD students (Anna Luzeńczyk and Szymon Smoliński) and one Post doc (Krzysztof Radtke) started in INSPIRE project.

LU

PhD student (Kim Berndt) is working for INSPIRE project in 2015.

8. Distribution of the project 's research staff and research organisations involved by age class, seniority and gender

Age group	PhD students		Post-docs		Assistants, lecturers, instructors and eq		Associate professors and eq		Professors and eq	
	F	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**
<= 24	0	0	0	0	1	0	0	0	0	0
25 - 49	5	5	1	5	15	13	9	11	1	4
50 - 64	0	0	0	1	4	7	3	11	0	4
>= 65	0	0	0	0	1	2	0	2	0	0

Annex 1

Information on participation of BONUS INSPIRE scientists in stakeholder committees

No	Last name	First name	Affiliation short	Committee
1	Arula	Timo	UT-EMI	ICES WGALES
2	Eschbaum	Redik	UT-EMI	ICES/OSPAR Working Group on Seabirds
3	Klais	Riina	UT-EMI	ICES WKSPATIAL
4	Ojaveer	Henn	UT-EMI	ICES WGBIODIV
5	Ojaveer	Henn	UT-EMI	ICES WGHIST
6	Ojaveer	Henn	UT-EMI	ICES WKSPATIAL
7	Ojaveer	Henn	UT-EMI	ICES CSWGIS
8	Ojaveer	Henn	UT-EMI	EC of the global network on Oceans Past Initiative
9	Ojaveer	Henn	UT-EMI	ICES SSGEPI
10	Ojaveer	Henn	UT-EMI	ICES SCICOM
11	Ojaveer	Henn	UT-EMI	ICES WGBOSV
12	Ojaveer	Henn	UT-EMI	ICES WGIAB
13	Ojaveer	Henn	UT-EMI	ICES WGITMO
14	Ojaveer	Henn	UT-EMI	ICES Awards Committee
15	Ojaveer	Henn	UT-EMI	EU JPI Oceans management board
16	Ojaveer	Henn	UT-EMI	HELCOM MARITIME
17	Põllumäe	Arno	UT-EMI	ICES WGIAB
18	Põllumäe	Arno	UT-EMI	ICES WGZE
19	Raid	Tiit	UT-EMI	ICES WGBFAS
20	Raid	Tiit	UT-EMI	ICESWGBIFS
21	Raid	Tiit	UT-EMI	ICES Baltic Sea Advice Drafting Group
22	Raid	Tiit	UT-EMI	ICES North Sea Advice Drafting Group
23	Raid	Tiit	UT-EMI	EC STECF EWG 1505 Landinging obligation
24	Raid	Tiit	UT-EMI	EC STECF EWG 1508 Effort management in the European seas
25	Raid	Tiit	UT-EMI	ICES WGBIOP
26	Neuenfeldt	Stefan	DTU Aqua	ICES WGIAB
27	Neuenfeldt	Stefan	DTU Aqua	ICES WKSIBCA
28	Neuenfeldt	Stefan	DTU Aqua	ICES WKSPATIAL
29	Neuenfeldt	Stefan	DTU Aqua	ICES WGSAM
30	Neuenfeldt	Stefan	DTU Aqua	ICES WGIPEM
31	Hüssy	Karin	DTU Aqua	ICES WKSIBCA
32	Eero	Margit	DTU Aqua	ICES WKSIBCA
33	Eero	Margit	DTU Aqua	ICES WGIAB
34	Eero	Margit	DTU Aqua	ICES WGBFAS
35	Eero	Margit	DTU Aqua	ICES WGHIST
36	Horbowy	Jan	MIR-PIB	ICES WGBFAS

37	Horbowy	Jan	MIR-PIB	ICES ACOM
38	Horbowy	Jan	MIR-PIB	ICES WKBALTCOD
39	Horbowy	Jan	MIR-PIB	ICES ADGBS
40	Luzeńczyk	Anna	MIR-PIB	ICES WKBALTCOD
41	Luzeńczyk	Anna	MIR-PIB	ICES WGBFAS
42	Luzeńczyk	Anna	MIR-PIB	ICES/HELCOM WGIAB
43	Radtke	Krzysztof	MIR-PIB	ICES WGBIFS
44	Radtke	Krzysztof	MIR-PIB	ICES WGRFS
45	Podolska	Magdalena	MIR-PIB	European Association of Fish Pathologists
46	Luzeńczyk	Anna	MIR-PIB	ICES WKGMSFDD3-II
47	Luzeńczyk	Anna	MIR-PIB	ICES ADGNS
48	Luzeńczyk	Anna	MIR-PIB	ICES ADGCS
49	Radtke	Krzysztof	MIR-PIB	ICES WGRFS
50	Smoliński	Szymon	MIR-PIB	ICES WGBIOP
51	Smoliński	Szymon	MIR-PIB	HELCOM FISH-PRO II
52	Blenckner	Thorsten	SU	ICES WGIAB
53	Niiranen	Susa	SU	ICES WGSPATIAL
54	Casini	Michele	SLU	ICES WKSPATIAL
55	Casini	Michele	SLU	ICES WGBFAS
56	Casini	Michele	SLU	ICES ADGBS
57	Casini	Michele	SLU	ICES WGCOMEDA
58	Casini	Michele	SLU	ICES WKBALTCOD
59	Casini	Michele	SLU	Workshop on Comparative Cod dynamics - identifying potential regulation by somatic growth analyses, DEMO2
60	Florin	Ann-Britt	SLU	ICES WGBFAS
61	Florin	Ann-Britt	SLU	Nordic Council Lumpfish Working group
62	Florin	Ann-Britt	SLU	ICES SIMWG
63	Florin	Ann-Britt	SLU	ICES WGITMO
64	Bergström	Ulf	SLU	Swedish national working group on marine spatial planning
65	Bergström	Ulf	SLU	Swedish national working group on fisheries regulations in marine protected areas
66	Bergström	Ulf	SLU	Swedish national reference group on marine green infrastructure
67	Bergström	Ulf	SLU	ICES WKSPATIAL
68	Bartolino	Valerio	SLU	ICES WKSPATIAL
69	Bartolino	Valerio	SLU	Workshop on Comparative Cod dynamics - identifying potential regulation by somatic growth analyses, DEMO2
70	Svedäng	Henrik	SLU	ICES WKBALTCOD
71	Svedäng	Henrik	SLU	ICES SIMWG
72	Walter	Yvonne	SLU	ICES WGBFAS
73	Alessandro	Orio	SLU	ICES WKSPATIAL

74	Alessandro	Orio	SLU	Workshop on Comparative Cod dynamics - identifying potential regulation by somatic growth analyses, DEMO2
75	Kornilovs	Georgs	BIOR	ICES WGBFAS
76	Ustups	Didzis	BIOR	ICES WGBFAS
77	Ustups	Didzis	BIOR	ICES WGIAB
78	Putnis	Ivars	BIOR	ICES WGIAB
79	Makarcuks	Andrejs	BIOR	ICES WGALES
80	Svecovs	Fausts	BIOR	ICES WGBIFS
81	Strods	Guntars	BIOR	ICES WGBIFS
82	Polte	Patrick	TI-OF	ICES WGALES
83	Polte	Patrick	TI-OF	ICES WGIPS
84	Möllmann	Christian	UHAM	ICES/HELCOM WGIAB
85	Möllmann	Christian	UHAM	*Workshop on Comparative Cod dynamics - identifying potential regulation by somatic growth analyses, DEMO2*
86	Möllmann	Christian	UHAM	Lenfest Ecosystem Fishery Task Force
87	Peck	Myron	UHAM	ICES WGIPEM
88	Peck	Myron	UHAM	ICES PUBCOM
89	Möller	Klas	UHAM	ICES WGZE
90	Otto	Saskia	UHAM	ICES/HELCOM WGIAB
91	Kallasvuo	Meri	Luke	HELCOM FISH-PRO II
92	Pönni	Jukka	Luke	ICES WGBIOP
93	Pönni	Jukka	Luke	ICES WGBFAS
94	Pönni	Jukka	Luke	ICES WGBIFS
95	Raitaniemi	Jari	Luke	ICES WGBFAS
96	Raitaniemi	Jari	Luke	ICES ADGBS
97	Raitaniemi	Jari	Luke	ICES WGECO
98	Raitaniemi	Jari	Luke	ASCOBANS Bycatch WG
99	Raitaniemi	Jari	Luke	ICES ADGNS
100	Raitaniemi	Jari	Luke	ICES ADGHERMA
101	Lehmann	Andreas	GEOMAR	Baltic Earth Scientific Steering Group, Member
102	Nissling	Anders	UU	Fisheries Management Gotland (FFG) - regional co-management of fishing

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

Report

First Annual Meeting

10-11 February 2015

Hamburg, Germany

Agenda item #1: Arrival and registration

First annual meeting of INSPIRE was held in Hamburg, Germany during 10-11. February 2015. The meeting was hosted by the University of Hamburg. The meeting agenda can be found in Annex 1. The meeting was attended by 25 participants (Annex 2).

Agenda item #2: Welcome and housekeeping

The meeting host Christian Möllmann welcomed meeting participants and introduced houskeeping rules.

Agenda item #3: Project coordination and reporting update

The project coordinator described and explained the requirements and details needed for the project annual reporting. Reports of work package leads and project partner institute PI's according to the required format is due 28. February. This will allow sufficient time for the coordinating partner to assemble all input and finalise the report to BONUS (due 31. March).

Agenda item #4: Database and data management

The draft database format for the INSPIRE gillnet and beach seine survey has been discussed in detail (Annex 3). Besides these survey data, the INSPIRE database will also include:

1. Adult cod tagging data (Deliverable 2.1)

The Deliverable is completed and accepted by BONUS. Metadatabase information can be found in Annex 4.

2. Sprat and herring spatial distributions from acoustic data

ICES sub-division specific spatial distributions of herring and sprat were generated using acoustic data and commercial landings for the period from 1978 onwards. These data basically comprise the best available measure of the changes in the distributions of these species during the last 35 years. The data will be stored in the INSPIRE repository and made available to analyses on the causes and consequences of the observed meso-scale changes in the spatial distirbutions of these clupeids.

3. Binaries from acoustic surveys for small-scale spatial distribution analyses

The binary raw data from acoustic surveys within INSPIRE will be stored and successively supplemented by historical acoustic data from the Baltic International Acoustic Survey and other research surveys. These data will be available to quantify small-scale distributions of herring and sprat, their impact on species interactions, their relation to total biomass, and furthermore enable innovative analyses of small-scale phenomena, for example investigating if there are any signals in the small-scale spatial structure before sprat leave a certain fishing ground from one day to another.

4. Cod stomach content data collected or worked up during the recent EU stomach tender

During the recent EU cod stomach tender, more than 105 000 individual stomachs were added to the cod stomach database. These data will be made available for several analyses of cod predation and its impacts on herring and sprat in INSPIRE.

5. Hydrography data

Cleaned datasets of hydrographic conditions (current directions, velocities, temperature, salinity, oxygen concentration) for the Baltic Sea with a vertical resolution of 2 km and temporal resolution of 6 hours in the years 1970 to date will be made available for several analyses on egg and larval drift, and other impacts of environmental conditions on species distributions.

6. Gulf of Riga pelagic fish and their prey

The dataset will include pelagic fish (incl. herring, sticklebacks, sprat and smelt) biomass and abundance data from hydroacoustic surveys carried out in the Gulf of Riga since 1999. In addition, it will include zooplankton abundance and biomass data (by taxa) by stations and stomach data of herring and sticklebacks.

7. Baltic Sea zooplantkon dataset

Baltic Sea zooplankton dataset http://www.sea.ee/huvitavat/balticzooplankton has been compiled by a joint effort of number of researchers from institutes that conduct or have conducted long-term monitoring of the Baltic Sea (Figure 1). The primary goal of the Baltic Sea mesozooplankton study initiative and data compilation effort is to assemble a pan-Baltic collection of raw zooplankton time series data in an effort to look at all-Baltic patterns and ecosystem dynamics at multiple spatial and cross-disciplinary scales. The dataset contains currently species counts and biovolume estimates from 23000 samples and ca 15 000 profiles provided by 7 institutes: Estonian Marine Institute, Tartu University (UT-EMI), Marine Research Centre, Finnish Environment Institute (SYKE), Institute of Food Safety, Animal Health and Environment (BIOR), Latvian Institute of Aquatic Ecology (LHEI), National Marine Fisheries Research Institute (NMFRI), Atlantic Research Institute of Marine Fisheries & Oceanography (AtlantNIRO) and Swedish Meteorological and Hydrological Institute (SMHI).

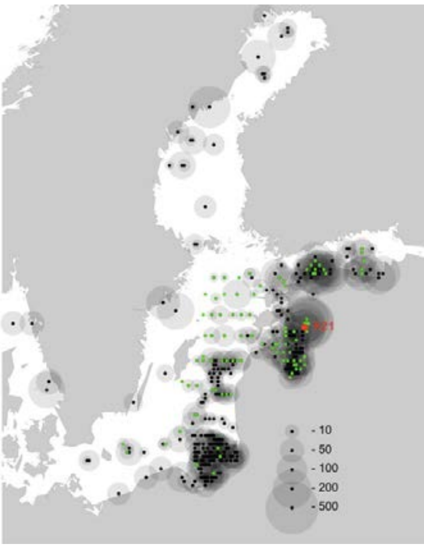

Figure 1. Density of the zooplankton data. Size of the bubbles corresponds to number of species from one location. Green dots mark the locations from where samples before 1965 have been taken (does not guarantee consistent series, though). Red dot marks the station "K21" in the Parnu Bay, from there, about 2000 samples have been collected between 1973 and 2011 (mean 50 samples per year). From Parnu Bay, relatively enclosed small bay, nearly 4000 samples have been collected between 1957 and 2011, which is the most extensively sampled area in the Baltic Sea http://www.sea.ee/huvitavat/balticzooplankton..

Datasets 1-5 will be stored at DTU AQUA and UT-EMI and dataset 6 at UT-EMI and BIOR. The INSPIRE consortium will develop a data policy as an addendum to the consortium agreement. This data policy will include consortium-internal rules for usage of the data including publication and usage for publication. The meta-data will be made available to ICES, however, the INSPIRE consortium agreed that we do not have the necessary resources to develop the project-internal database to a public database fulfilling ICES standards.

Agenda item #5: Fish surveys

Sprat and herring

1. Research highlights

Recorded herring densities were low in May, that can be expected since most of the adult herring is on near-coast spawning grounds at this time. In October, the observed acoustic densities of herring were relatively high, particularly in the Sub-divisions 29 and 32 giving the average abundance >3 million per nm^2 over a wide area. Results of the two ichthyoplankton surveys showed that the southern part of the investigation area was more important for reproduction of sprat. Although sprat eggs were also found in the northern Baltic Sea, larvae were encountered in the southern part only.

2. Results of the field work in 2014

2.1. Preliminary results of acoustic surveys BASS (May, 2014).

The survey covered ICES Sub-divisions 28.2, 29 and 32W. Recorded herring densities (Figure 2), were low that can be expected since most of the adult herring is on near-coast spawning grounds during the BASS survey in May. The results of the survey are included in the BAD2 database (ICES) and are available for INSPIRE.

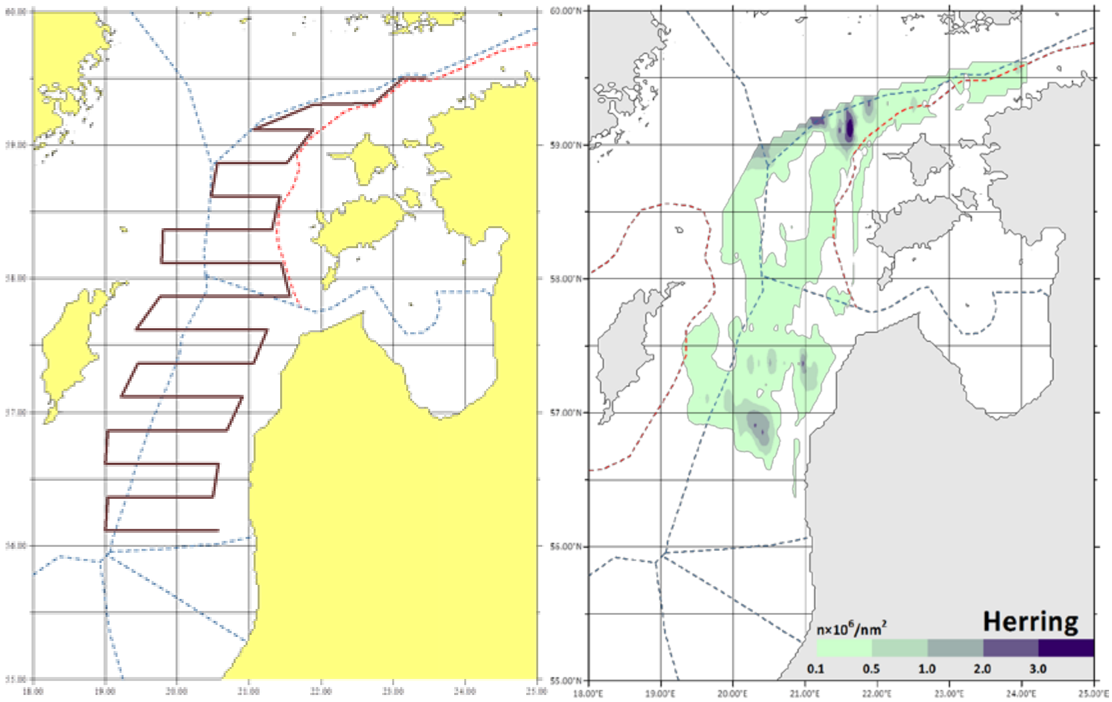

Figure 2. Acoustic survey track in May 2014 and 2015 and herring distribution in the Baltic Sea ICES SD 26N, 28, 29SE and 32W (Latvian-Estonian hydroacoustic survey on f/v "Ulrika", 14-26.05.2014).

2.2. Preliminary results of acoustic survey BIAS (Baltic International Acoustic Survey) (October, 2014).

The area of ICES sub-divisons 28.2, 29 and 32 was covered with two consecutive sub-surveys (LAT-POL and EST-POL). The observed acoustic densities of herring were relatively high, particularly in the Sub-divisions 29 and 32 giving the average abundance >3 million per nm^2 over a wide area (Figure 3). Besides to the acoustic tracking and control trawl hauls, zooplankton (13) and feeding samples (270 for herring and 170 for sprat) were collected at each trawl station in Sub-divisions 29 and 32. The analysis of samples is ongoing at EMI-UT. The results of the acoustic survey are included in the BAD2 database (ICES) and are available for INSPIRE.

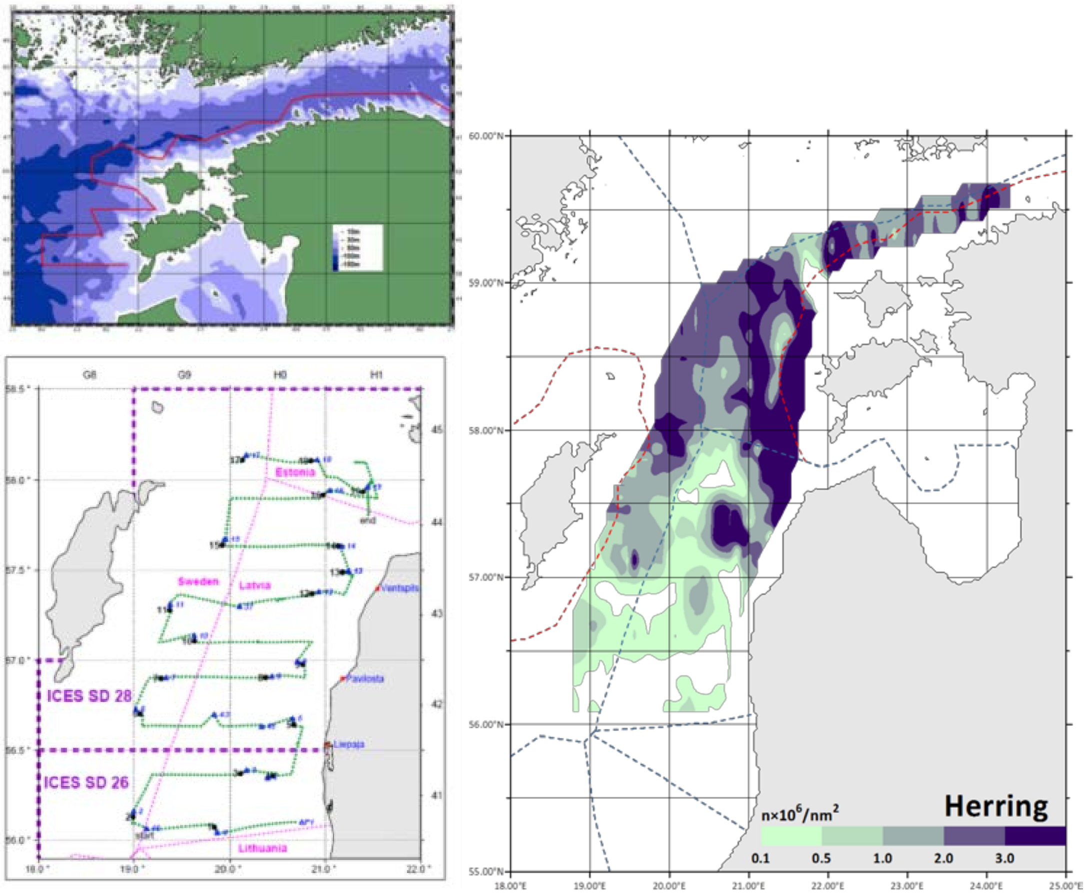

Figure 3. Acoustic survey track in October 2014 and 2015 and herring distribution in the Baltic Sea ICES SD 26N, 28, 29SE and 32W (Latvian-Polish-Estonian hydro-acoustic survey on r/v "Baltica", 09-27.10.2014).

2.3. Preliminary results of ichtyoplankton field surveys

Two ichthyoplankton surveys (in May and June) were performed in the open Baltic Sea by covering Sd 26N, 28, 29, 32W. Samples were collected with IKS-80 ichthyoplankton net. The samples were collected by vertical trawling from the depth of 100 m or bottom till the surface and by horizontal trawling in the upper water layer. The samples were preserved in formaldehyde solution and treated in laboratory. All sprat eggs were measured and the development stage was determined. The collected sprat larvae were deep-freezed at -86 degrees for further RNS/DNS analysis (see section 1.4. below).

In May, the main sprat egg distribution area was in the southern part of the survey area - Sd 26N and 28. In the northern part the abundance of sprat eggs was substantially lower. Sprat larvae were met only in the southern part of the area. The distribution of adult sprat and percentage of the spawning sprat females in the survey area was rather even and could not explain the observed pattern in the distribution of sprat eggs and larvae. In June, distribution of sprat eggs was more even in all survey area, however sprat larvae were met only in the southern part of the area (Figure 4).

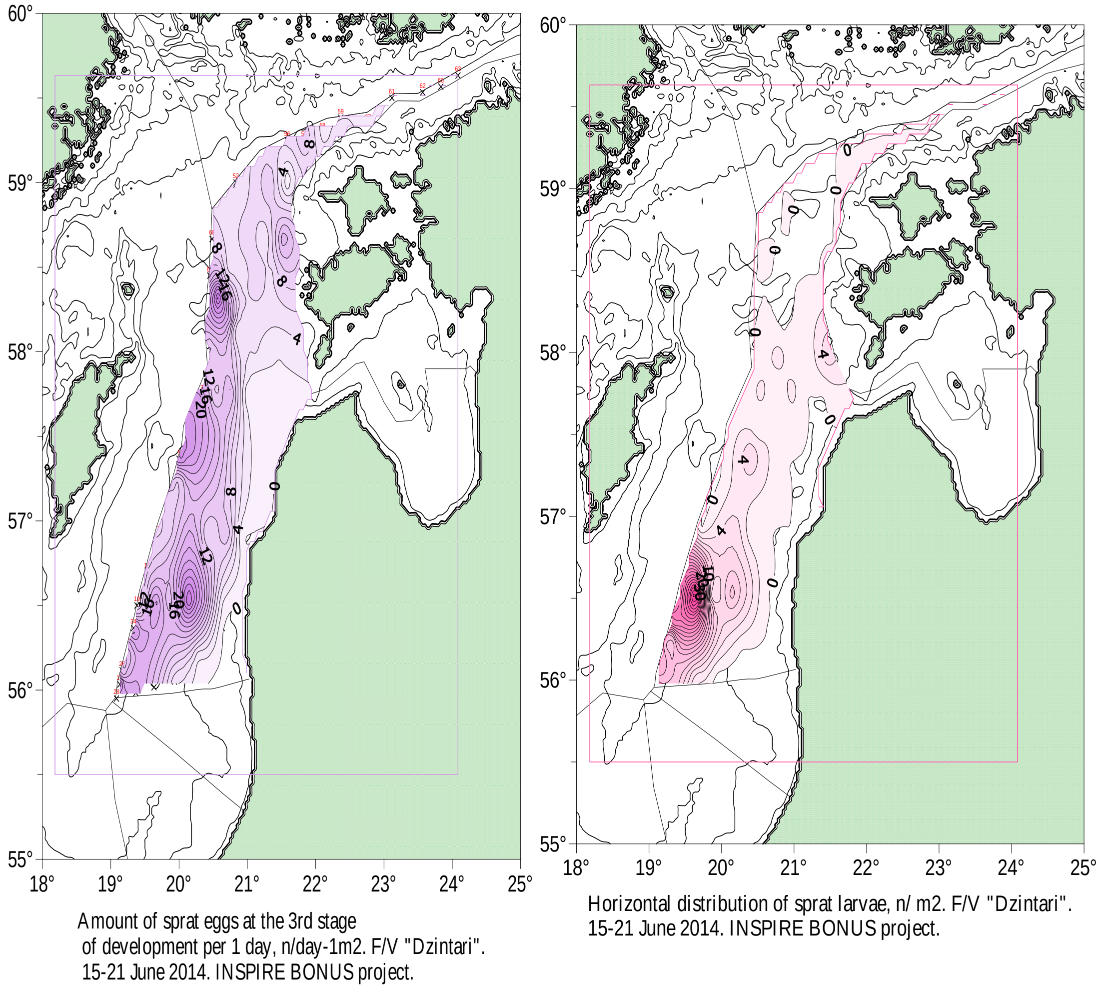

Figure 4. Distribution of sprat eggs (left panel) and larvae (right panel) during ichtyoplantkon surveys in June, 2014.

2.4 Preliminary results of biochemistry analysis of larval sprat

Analysis of bulk ribonucleic acids (RNA) and deoxyribonucleic acid (DNA), conducted in the lab of University of Hamburg, provide indices for estimating size, condition and growth of fish larvae. We used the ratio of RNA to DNA (R/D) to describe larval sprat condition. The analyses is based on RNA, which comprises much of the cell’s machinery for protein synthesis, fluctuates in response to food availability and the demand for protein synthesis, while DNA content is an index of cell number or biomass, and remains relatively constant during periods of starvation. As the R/D values are strongly coupled to individual weight and length, all sprat larvae were measured before analyses. Initial results indicate that dry weight of sprat larvae was relatively low in individuals with SL < 8mm, but increased rapidly for larger larvae. Values of R/D also increased with larval size suggesting low nutritional condition of younger/smaller larvae compared to larger inviduals collected at the time of the survey. (Figure 5). However, due to generally low dry weight of larvae (most individuals Dw < 130µg), samples needed to be polled, which greatly reduced the number of samples available for R/D analyses.

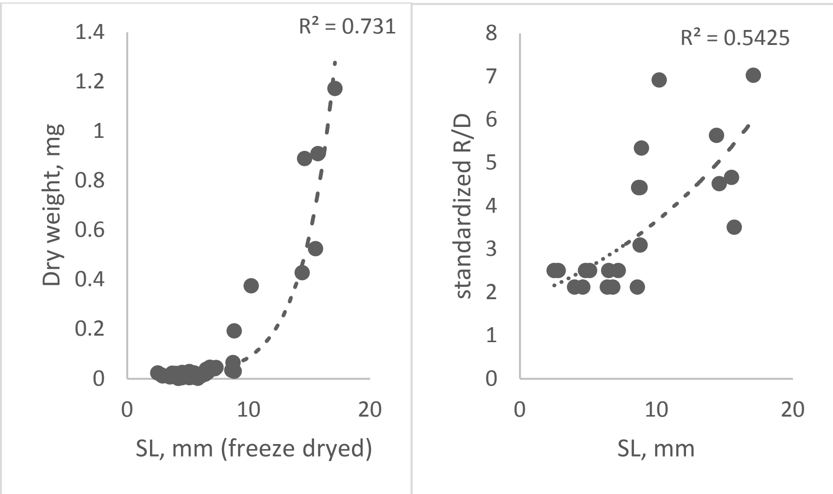

Figure 5. Relationship between larval sprat standard length (SL) and dry weight (left panel) and between standard length (SL) and R/D ratio (right panel).

3. Plans for the field work in 2015

3.1. Small scale distributions

A survey with the German RV ALKOR will be conducted in spring in the Bornholm Basin to evaluate small-scale distributions of cod, pelagic planktivores and zooplankton. Drivers of species distribution and overlap will be investigated at small temporal and spatial scales using a TRIAXUS, a towed multi-purpose ecosystem profiler equipped with probes for physics, chl a, acoustics for plankton, a Video-Plankton-Recorder (VPR) and a Laser Optical Plankton Counter (LOPC).The cruise will have a focus to evaluate the consequences of the recent major Baltic inflow on the stucture and function of the pelagic Baltic ecosystem.

3.2. Ichtyoplankton

It is planned to perform ichthyoplankton surveys both in May and June as done in 2014. However, taking into account that the number of collected sprat larvae was low in 2014 and there was a need for more larvae for RNS/DNS analysis, it was decided to use also Bongo net for collection of sprat larvae. The Bongo net will be applied in places where the number of larvae is sufficiently high. This will increase the survey time therefore the June survey is planned 8 days long.

3.3. Acoustic survey

The aim of the survey is to determine the distribution pattern of pelagic fishes in the eastern Baltic in May and to tie it with the collection of ichthyoplankton samples to determine the main spawning areas of sprat. Altogether app. 25-30 control trawl stations accompanied by the CTD probe and mezo-zooplankton sampling will be covered during the survey along the standard transects of the acoustic surveys (app. 2 hauls per statistical rectangle; Figure 2).

3. 4. Complex survey

The aim is to collect the information on statutory survey track of the BIAS, covering the Latvian and Estonian EEZ from Sub-divisions 26 to 32 on board of RV BALTICA. The zooplankton samples will be collected in all control haul stations with Juday net. The total of app. 25-35 trawl control haul stations accompanied by the CTD probe will be covered during the survey along the standard transects of the acoustic surveys (app. 2 hauls per statistical rectangle; Figure 3). In addition to the standard sampling from control hauls, the feeding samples (5 fish per 0.5 cm length group per Sub-division) will be collected both for herring and sprat. Thus the total number of feeding samples will be app. 100-200 for sprat and 200-300 for herring. For feeding investigations the stomachs of herring and sprat will be collected and preserved in 4% formaldehyde solution for further analysis. Besides to the stomachs the total length, average size group weight will be recorded and the otoliths taken. The stomachs will be analysed by EMI-UT. In order to get the information on feeding conditions the zooplankton samples with Juday net will be taken from each trawl haul stations, 25-35 altogether. The standard methods of zooplankton surveys will be applied for treatment and storage of samples. Timing of the survey: October 2015 (20 days). Logistics of the survey: The BIOR will cover first the Sub-divisions 26 and 28-2 (10 days), following by the survey in Sub-divisions 28-2-32 conducted by the UT-EMI (10 days).

3.5. Feeding ecology of clupeids

The investigation of feeding of herring and sprat will be performed on 5 transects in the ICES sub-divisions 28.2, 29 and 32 (Figure 6). 5 30- minute trawl hauls will be performed at each transect with conventional pelagic trawl. The catch will be sorted according to species composition and the standard biological analyses of sprat and herring will be performed. Every trawl haul will be accompanied by the CDT profile (temperature and salinity) and the zooplankton sample. The zooplankton will be sampled with Juday plankton net using the vertical hauls from bottom to surface. The collection and analyses of sprat and herring feeding samples will be conducted according to standard techniques (Melnitchuk, 1980). 5 stomachs per length group will be collected for the analyses. The estimates total number of collected stomachs will be 1500 for herring and 1000 for sprat. Timing of the survey: July 2015 (7 days).

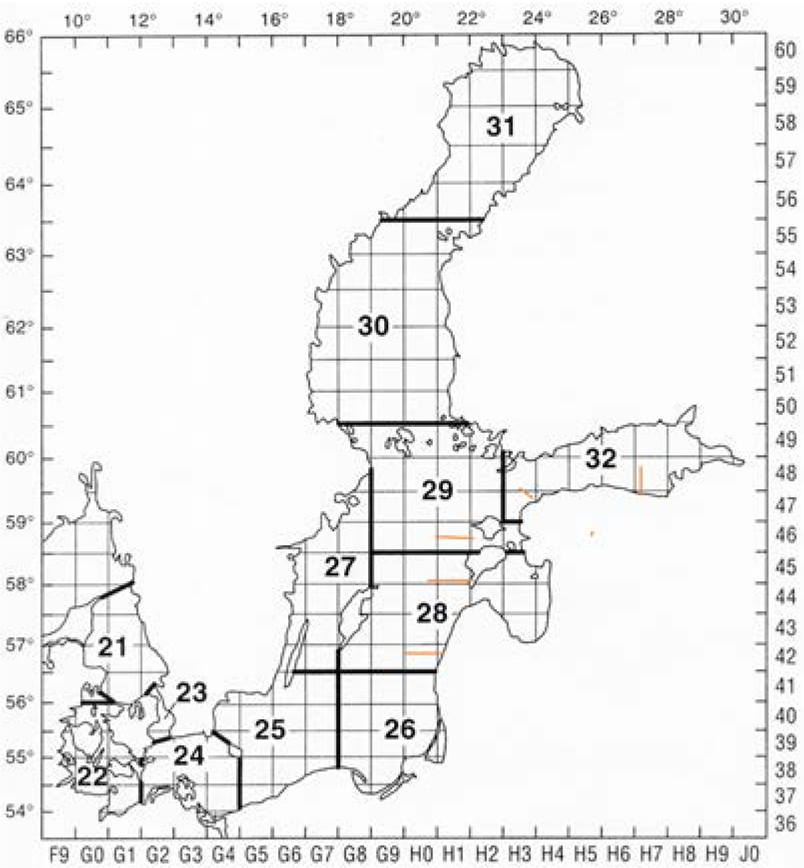

Figure 6. Approximate location of transects in the North-eastern Baltic and the Gulf of Finland in July 2015.

Cod and flounder

1. Research highlights

The results from flounder egg-density surveys in southern and eastern Baltic Sea performed by Anders Nissling (UU) was presented. Furthermore his first years egg and spermatozoa investigations made in conjunction with the gillnet survey revealed existence of both types of flounder, coastal and offshore spawning type, in both the investigated areas – Eastern Gotland basin and Hanö Bay. This experiments will be repeated in 2015.

Data from the beachseine surveys in Latvia were used by Didzis Ustups et al. (BIOR) to reveal food competition between juvenile flatfish and the invasive round goby.

2. Results from cod and flatfish surveys

2.1 Gillnet surveys (by Ann-Britt Florin, SLU)

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 special float lines were used. All 11 transects were carried out according to plan in the spring (Figure 7). However, due to bad weather conditions, it was not possible to fish transect I in the late autumn sampling.

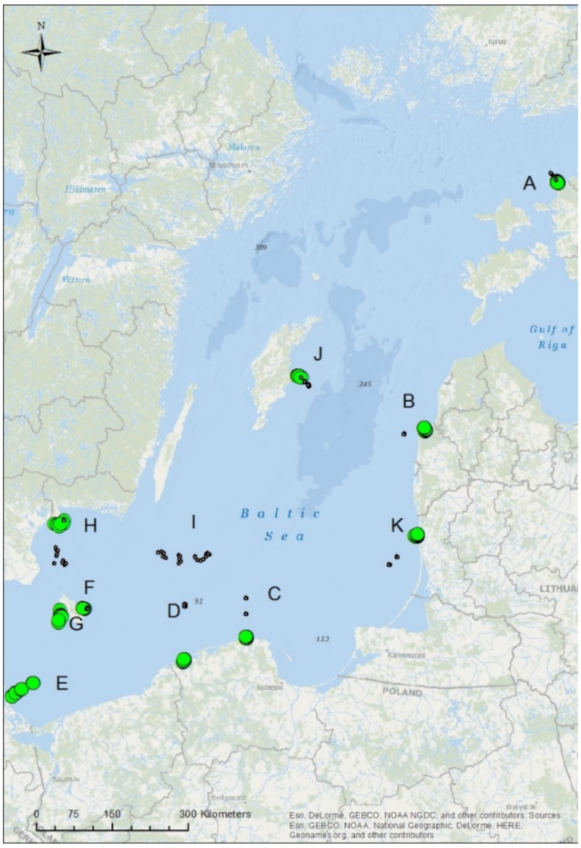

Figure 7. Fished gillnet stations in spring & autumn 2014. Green circles represents stations fished both in spring and autumn while black dots represents the deeper stations only fished at spring.

CTD casts are available for 9 of the transects, for the others temperature and salinity was recorded manually at depth intervals. 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 are oxygen and habitat which are missing from 3 transects in the spring and 2 respectively 1 transect in the autumn due to delayed delivery or malfunction of equipment.

In total 37 fish species were recorded. The total catch of the target species were 2564 flounders and 74 small cod (≤20cm) in the spring and 764 flounders and 20 cod (≤20cm) in the autumn.

Sampling of individuals was performed according to the plan; 2077 otoliths and 1378 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 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 achieved regarding areas and depth fished and sampling of flounder. However, only very few juvenile cod have been caught. The sampling scheme was very intense and a revision of the manual simplifying registration and lessening the burden of the field personal is advised. All PIs are ready to perform 2015 surveys and all equipment, gillnets, cameras and oxygen are now in place.

2.2 Beach seine surveys (by Didzis Ustups BIOR)

Before the sampling season all countries developed and accepted Beach seine manual. According to the 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 set from July to middle of September however it could be modify according to local expertise about flounder settling in particular area.

All planned transects were performed (Figure 8). 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 1).

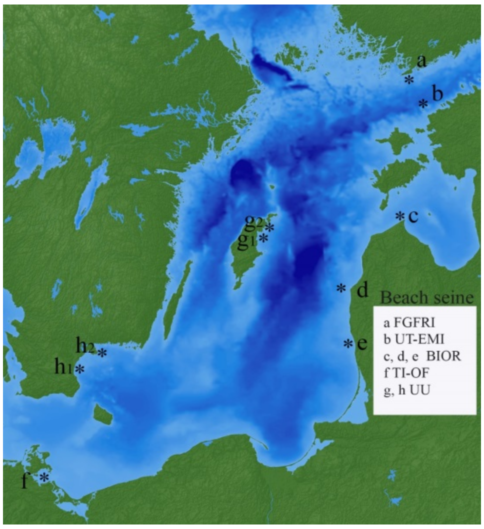

Figure 8. Map of the INSPIRE beach seine survey sampling locations. Asterisks and letters identify the locations for the beach seine surveys. The letters in the legends correspond to these locations and identify the institutes responsible for each survey location.

Transect A is part of a Finnish 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 beach seine surveys.

Table 1. 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						
Sweden						
Latvia						
Estonia						
Finland						

High abundance of flounder juveniles was detected in transects c, d, e, g and h. All transects with high abundance were located in the Central Baltic Sea. According to preliminary results from the Central Baltic 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 transects. Due to available limited funding some countries could not collect otoliths and fish are still preserved in ethanol.

3. Feed into deliverables

Data from the surveys will feed into D.1.1 Database, D 1.2 Report on distribution maps, D 1.3 simulating spatial distribution, D.1.4 Overlap indices, D. 1. 5 Habitat preferences, D. 1.7 Design protocol. Data gathered in conjunction with survey will also feed into 4.2 Stock evaluation for flounder.

4. Discussions & decisions & planning of 2015

1. *What to do in response of the poor catch of juvenile cod?*

   Decision: Adult cod was upgraded to Prio 1 species for the surveys but the collection of genetic samples and stomach samples is not mandatory. It was also decided to keep the current manual for the survey since the low abundance of juvenile cod is probably a true effect of poor recruitment rather than deficiency of the survey.

2. *What to do with collected otoliths?*

   Decision: Use asymmetric otolith for age reading and save the symmetric otoliths for later otolith chemistry analyses. Age reading of flounder should be undertaken but for cod it is not mandatory. There is no need for calibration within the INSPIRE project since this anyway takes place in other projects.

3. *When to start with otolith chemistry and genetic analysis?*

   Decision: Flounder champion together with BIOR should draft specifications for the sub-contractor for chemistry analysis asap. Selection of otoliths & genetic samples to analyze within INSPIRE should take place within the spring in dialog between P.I.s (SLU leading for flounder, DTU-Aqua for cod, other key P.Is are UU & BIOR).

4. *What to do with collection of stomachs?*

   Decision: The stomachs already collected should be kept in the freezer for future reference but no new stomach samples is mandatory to sample within INSPIRE.

5. *How to score habitat variables from videos and surveys?*

   Decision: Variables should be recorded manually, preferentially only one person should do all the scoring, if this turns out impossible it is important to get a reference image sampling so that different persons score habitats the same. It was decided that all PI:s should start looking at their videos to get a feeling for what could be recorded, a draft of potential habitat variables to score were agreed and added to the template for data storage.

6. *Skip registration on mesh size for individual samples to limit the registration load?*

   Decision: Individual data have been registered by meshsize in 2014 and hence it would be possible to investigate effect of meshsize on other parameters in the future. To limit the registration load it was decided to make registration per meshsize for individual data optional. Catch data must still be registered by meshsize.

7. *Reduce flounder parameters in autumn survey to limit the registration load?*

   Decision: Since flounders are sparse in the autumn this will not change the workload and therefore parameters are kept as in the existing manual.

8. *Should there be any changes in the beach seine surveys in 2015?*

   Decision: All transect will follow manual for sampling time and parallel trawling in 2015, despite few individuals caught in Germany and Estonia the same sampling time and places are kept to the next year.

9. *Template for gillnet and beach seine database*

Decision: A template for the structure of the data from the gillnet and beach seine surveys was agreed upon. The template follows to a certain extent the DATRAS format, but with additional fields to hold the particular specifications of the two surveys that are not in the DATRAS format. Each partner will be responsible for data quality assurance of their own data. The data from all partners will be compiled, maintained and distributed to all partners by DTU Aqua.

Agenda item #6: Herring ecology review

One of the major tasks in INSPIRE is to establish databases for the four fish species for further analysis and modeling efforts. However, abundant historical published/written material also exists for several commercial species. It was discussed and agreed during the 1st Integrating Workshop to start compiling such information for herring and establish catalogues with historical publications, incl. those written in national languages. Knowledge extracted and synthesized 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.

The activity is being led by Christian Möllmann and Patrick Polte, carried out intersessionally and discussed further at the 3rd Integrating Workshop of the project later in 2015.

Agenda item #7: Round goby research in INSPIRE and cooperation with BONUS BIO-C3 project

Many round gobies were caught during INSPIRE gillnet and beach seine sampling in several countries in 2014. Jan Niemax (PhD student at University of Hamburg) was invited to attend the meeting to discuss possible cooperation between INSPIRE and BIO-C3 for the round goby research. His PhD project involves both lab. and field surveys. In the lab., the influence of different salinity / temperature combinations on the development and hatching success in eggs of the round goby will be investigated.

The fieldwork is planned to investigate the following migrations aspects of the species in Lübeck Bight:

1) Seasonal migration between freshwater and marine habitat
2) Seasonal migration in depth
3) Abundance change related to the distance to river mouth.

In addition, trophic relations between the round goby and cod, by including investigations on spatial overlap between these species is of interest. In this purpose, stomach data of cod would be required. In addition, there are several data of interest that INSPIRE scientists gather during gillnet/seine fishing. These are, amongst others: abundance of cod, round goby and black goby by gear and depth, as well as length, weight and sex data. In addition, environmental data, such as water temperature and salinity would be needed. The data policy that will be prepared as addendum to the consortium agreement will elucidate the terms of use of these data for users external to INSPIRE (please see the last paragraph of the Agenda item #4 on pages 4 and 5).

The meeting discussed information and data needs and suggested that INSPIRE could pragmatically offer access to the resource, i.e., invited Jan Niemax to join INSPIRE cruises and collect all data needed for his research. However, and unfortunately, INSPIRE scientists are very busy during the cruises to fulfil the INSPIRE project plan. Therefore, it was decided that INSPIRE PI’s will fill out the simple xls sheet on field works plan for 2015 and Jan Niemax can use this information to plan his research.

Agenda item #8: Links to WP4 and WP5

Work Package 4

The aims, methodologies and activities performed and planned in WP4 were presented and discussed. In particular, the range of information being collected in WP1 (Distributions) and produced by WP2 (Movements) and WP3 (Scaling) that might be useful for WP4 was considered.

The WP4 has two major objectives: (a) to include and quantify the effects of migrations and spatial and temporal changes in exploited fish distribution (cod, herring, and sprat) on stock assessment, and (b) to provide assessment of the status of flatfish in the Baltic, as a basis for quantitative management of these stocks.

Assessment part of the project started a few months ago, and as the WP4 depends very much on the new data and compiled historical data, no assessments were performed yet, which is according to the work plan.

However, significant progress has been achieved in Task 4.2 (Stock identification of flounder in the Baltic Sea) in which reference data for spawning types characteristic (egg and spermatozoa characteristics) has been collected. Genetic analyses were performed and data were obtained for statistical analyses of genetic differentiation between sampled sites. Data for other methods to evaluate stock differentiation have been prepared (morphometric and advanced otolith micro-chemistry).

The results of the autumn gillnet survey (WP1) indicated almost lack of young cod in shallow waters, which may lead to serious difficulties in developing recruitment indices for young cod, basing on that survey.

Preparation to separate assessment of herring and sprat from northern areas has started. The available historical data for the separate assessments of herring according to the assessment units used by ICES prior to 1990 has been revised.

Based on the analysis of weekly resolved surveys on herring larvae during May-July in 2004-2013, significant relationship between the abundance of large larvae (17-20 mm) and herring recruitment was established in the Gulf of Riga. This input information from WP3 may be useful in future assessment of herring stocks.

Work plan for WP4 presented in DoW was also discussed in the light of the serious problems in cod stock assessment discovered in 2014, i.e. after the INPIRE project has started. Due to these problems ICES was unable to provide analytical assessment and advice for 2015. Discovered problems in cod assessment and changes in cod ecology may be summarised as:

a. very bad retrospective pattern of eastern cod assessments,
b. inconsistencies between fisheries and survey information – unstable catchability,
c. serious problems with age reading – no consistency even within a country,
d. strongly declining condition of cod and probably growth,
e. strongly increasing infection of cod with nematodes, with some indications of having impact on cod's natural mortality,
f. decreasing overlap of cod and clupeids,
g. enlarging hypoxic/anoxic areas affecting cod distribution.

In the light of above findings/problems it was suggested to put in the project more emphasis on cod issues than it was originally planned, as without realistic cod assessment it may be difficult to correctly determine the dynamics of clupeids stocks.

Work Package 5

The aims and activities for WP5 (Ecosystem-based management) were shortly discussed. The work conducted here will have strong links to WP1-WP4 and also to WP6 dissemination. Concerning task 5.1., it was agreed, that instead of Ecospace modeling approach, a more advanced spatial dual-modelling approach combining Bayesian belief network and Size-structured food-web modelling will be applied here.

Food-web modeling will be introduced first for the Central Baltic area and then later expanded to the Northern Baltic Sea, if possible. Tasks 5.2. and 5.3. will be further planned in the next 3rd Integrating Workshop.

Agenda item #9: AOB and wrap up the meeting

Baltic Health Index (BHI)

As decision-makers shift towards more comprehensive approaches to managing ecosystems, management goals and targets increasingly focus on overall ecosystem health rather than on single sectors or stressors. This trend is particularly apparent for marine ecosystems. Recently international assessment the Ocean Health Index has been developed (Halpern et al. 2012). On 1. Jan 2015, a project has started by Stockholm University with the ambition to develop a regional study, the Baltic Health Index (BHI), scientifically led by Thorsten Blenckner. The aim of the BHI will be to assess the health of the sea in the relatively data-rich Baltic Sea region. The BHI will be developed in collaboration with scientists as well as policymakers and experts in countries around the Baltic Sea. The BHI will a) have the capacity to inform and guide regional marine ecosystems managers and policy makers, b) reflect regional priorities by modifying goal weights according to local priorities and c) to assess the impact of potential actions through “management scenario” studies. A state-of-the-art transdisciplinary research project, the BHI strives to create a new, comprehensive understanding of the health of the marine ecosystems in the Baltic Sea and is expected to heavily impact management in the region. Amongts others, the project is expected to incorporate the expertise and knowledge of various scientists participating in INSPIRE. These will be contacted by the BHI project lead.

Halpern et al. 2012. An index to assess the health and benefits of the global ocean. Nature 488: 615-622. www.nature.com/doifinder/10.1038/nature11397

Annex 1. Meeting Agenda

Agenda

INSPIRE 2015 Annual Meeting

Institute for Hydrobiology and Fisheries Science (IHF), University of Hamburg,

Grosse Elbstrasse 133, 22767 Hamburg

Tuesday, 10. February

09:00-09:15	**Agenda item #1**: Arrival and registration
09:15-09:30	**Agenda item #2:** Welcome and housekeeping
09:30-10:00	**Agenda item #3:** Project coordination and reporting update
10:00-10:15	*Coffee/Tea*
10:15-12:00	**Agenda item #4:** Database and data management
12:00-13:00	*Lunch*
13:00-15:00	**Agenda item #5:** Fish surveys i) research/results highlights ii) feed into deliverables iii) potential revision of 2014 guidelines and planning for 2015
15:00-15:15	*Coffe/Tea*
15:15-16:00	**Agenda item #5** continued
16:00-17:00	**Agenda item #6:** Herring ecology review
17:30-19:00	*Steering Committee meeting (by invitaion for PI's only)

Wednesday, 11. February

09:00-10:00	**Agenda item #5** continued **Agenda item #7:** Round goby research in INSPIRE and cooperation with BONUS BIO-C3 project
10:00-10:15	*Coffee/Tea*
10:15-11:30	**Agenda item #8:** Links to WP4 and WP5
11:30-12:00	**Agenda item #9:** AOB and wrap up Annual Meeting

Annex 2. List of participants

	Name	Partner
1	Henn Ojaveer	UT-EMI
2	Tiit Raid	UT-EMI
3	Timo Arula	UT-EMI
4	Christian Möllmann	UHAM
5	Jens-Peter Herrmann	UHAM
6	Jan Niemax	UHAM
7	Georgs Kornilovs	BIOR
8	Didzis Ustups	BIOR
9	Michele Casini	SLU
10	Ann-Britt Florin	SLU
11	Ulf Bergström	SLU
12	Alessandro Orio	SLU
13	Stefan Neuenfeldt	DTU-AQUA
14	Karin Hüssy	DTU-AQUA
15	Andreas Lehmann	GEOMAR
16	Katharina Höflich	GEOMAR
17	Meri Kallasvuo	LUKE
18	Jukka Pönni	LUKE
19	Jan Horbowy	MIR-PIB
20	Krzysztof Radke	MIR-PIB
21	Dorothee Moll	TI-OF
22	Patrick Polte	TI-OF
23	Thorsten Blenckner	SU
24	Stuart Kininmonth	SU
25	Susa Niiranen	SU

Annex 3. DRAFT: INSPIRE gillnet and beach seine surveys database fields (original in xls format)

ENVIRONMENTAL DATA		
Stationda	Transect	
	Station	
	LAT DD	
	LONG DD	
	Year	
	Month	
	Day	setting
		lifting
	CTD file	
	Video file	
Physical &	Depth (0.1 m)	
	Temp at surface dg C	
	Temp at bottom dg C	
	Salinity at surface PSU	
	Salinity at bottom PSU	
	Oxygen mg/l ar bottom	
	Wind dir Degree	
	Wind speed m/s	
	Secchi depth (m)	
	Turbidity	
Substrate	Silt & Clay (<0.06mm) % coverage	
	Sand (0.06-2mm) % coverage	
	Gravel (2-60mm 9 % coverage	
	cobble 60-200mm % covearge	
	Boulders 200-600mm % covearge	
	Large boulder > 600 mm % coverage	
	Bedrock % Coverage	
Vegetatio	Fucus % coverage	
	Fucurella % coverage	
	Vascular plants % coverage	
	Filamentous algae % coverage	
	Drifting Algal mats / % coverage	
Other	Mytilus % coverage	
	Dreissena % Coverage	
	Dreissena % Coverage	

CATCH DATA							
Stationdata	Transect						
	Year						
	Month						
	Day	setting					
	Day	lifting					
fishing	hours						
	Time (local)	setting	first net				
		lifting	last net				
	Station or haul						
	Depthinterval						
Fishing data	Gear						
	Area covered (for beach seine)						
	Meshsize (mm)						
	Disturbance yes/no	algae	seal	storm	jelly	gobies	large cod
	Cause of disturbance						
Biological data	Species	WORMS					
	Total weight per species/meshsize/sample	PER MESHSIZE					
	Weight of subsample if not all fish measured	PER MESHSIZE					
	Number of ind, in subsample	PER MESHSIZE					
	Length (cm)						
	Number of fish						

INDIVIDUAL DATA	
Transect	
Year	
Month	
Day	setting
Day	lifting
Station	
Depthinterval (5, 10, 20, 50 or 70)	
Meshsize	
Species	
ID	single fish
Totallength (mm)	
Total weigth (g)	
Somatic weight (g) (intestines & gonads & liver removed)	
Gutted weight (only intestines and liver removed)(g)	
Sex (F,M)	
Maturitystatus (1-6)	
Sidedness (flounder) (L, R)	
Otoliths removed (yes/no)	
Age	lagged
Aging met	lagged
Genetic sample (ID)	
Disease/parasites code	
Stomach sample (ID)	
Other	

OTHER
Description of gear

Annex 4 . Adult cod tagging database description (INSPIRE D2.1)

No.	Descriptor	Information
1	Title of dataset	Cod historical tagging data
2	General description of the dataset	The data include tagging experiments, both traditional and data storage tags (DST).
3	Keywords	Baltic, cod, tagging, migrations, data storage tags
4	Parameters in the dataset	Releasre recapture time and position; for DST temperature and pressure for individual cod every 10 minutes while at liberty.
5	Area covered	Whole Baltic Sea
6	Spatial resolution	Individual positions
7	Time span covered	1969-1985
8	Temporal resolution	Tagging data
9	Data quality	Computerized data from historical paper protocols
10	Date created	01-02-2015
11	Last update	01-02-2015
12	Availability	Project limited, upon request
13	Originator/Contact	Christian Möllmann, christian.moellmann@uni-hamburg.de
14	Location of dataset	UHAM, DTU AQUA, UT-EMI
15	Reference to sources other datasets	
16	BONUS project	INSPIRE
17	WP	2