BONUS

SCIENCE FOR A BETTER FUTURE OF THE BALTIC SEA REGION

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

INSPIRE

Deliverable No: 7.2		Workpackage number and leader: WP 7, UT-EMI	
Date:	8. March 2015	Contract delivery due date	31. March 2015
Title:	Integrating workshop report WS2		
Lead Partner for Deliverable:	UT-EMI		
Author(s):	Henn Ojaveer, Möllmann, C., Polte, P., Arula, T., Bergström, U., Blenckner, T., Casini, M., Florin, A-B., Herrmann, J-P., Hinrichsen, H-H., Horbovy, J., Höflich, K., Hüssy, K., Kallasvuo, M., Kininmoth, S., Kornilovs, G., Lehmann, A., Moll, D., Möller, K.O., Neuenfeldt, S., Niiranen, S., Orio, A., Pönni, J., Raid, T., Temming, A., Ustups, D.		
Dissemination level (PU=public, PP=Restricted to other programme participants, including the BONUS Secretariat, CO=confidential)			PU
Nature of the Deliverable (RE, RE/SP, RE/PP, RE/PR, RE/FR, SP, PP, ER, MO, PT, DE, TE, OT)			RE
Report Status (DR = Draft, FI = FINAL)			FI

Acknowledgements

The research leading to these results has received funding from BONUS, the joint Baltic Sea research and development programme (Art 185), funded jointly from the European Union's Seventh Programme for research, technological development and demonstration and from national funding institutions

INSPIRE Overview

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

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

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

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

www.bonus-inspire.org

Executive Summary

The current report provides information on the discussions held and decisions made at the second integrating workshop of INSPIRE. The overall aim of integrating workshops in the project is to ensure allowing timely discussions of important issues of the project to secure timely submission of project deliverables. The current workshop was aiming at linking essentially activities of WP2 and WP3, but also meeting WP4 and WP5 needs. The following major issues discussed at the meeting were related to science delivery of the project and organized by the following three separate sessions:

- Small-scale distributions of cod and clupeids
- Spatial distributions of key species and life-stages
- Species migrations based on traditional tagging data

In addition, two sub-groups were formed to discuss: i) herring overview manuscript, and ii) pan-Baltic larval herring study. Both these cross WP integrative activities in herring will take several years and result in multi-authored manuscript(s).

Introduction

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

The second integrating workshop was held in conjunction with INSPIRE annual meeting, hosted by University of Hamburg during 11-13. February 2015. The meeting was co-convened by Christian Möllmann (UH) and Patrick Polte (TI-OF). The meeting was attended physically by 26 participants.

Core activity

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

Session #1: Small-scale distributions of cod and clupeids

Planning science delivery of Work Package 2.

WP2 uses statistical and process-based techniques to study the movements of the focal species at different temporal and spatial scales and in different life-stages. A major task of WP2 is to track drift patterns of cod and flounder eggs and larvae using existing hydrodynamic model and Lagrangian particle-tracking techniques. Using these modelling techniques long-term trends in oxygen-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 Baltic cod early life stages. The suitability of environmental conditions for egg survival was tested in the different spawning grounds. Further, the population connectivity of cod eggs and yolk-sac larvae was estimated.

Additionally, connectivity processes between the two Baltic cod stocks has been investigated. The amount of surviving cod eggs, represented in the model system as virtual drifters, has been determined through the level of oxygen concentrations. Eggs initially released as drifters in the most western spawning grounds were strongly affected by sedimentation to the sea floor. Temperature-dependent mortality of cod eggs was evident after severe winters. The combination of topographic features and egg buoyancy appears 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. Two manuscripts (**D2.2 Manuscripts (2) on tracking eggs and larvae (M18)** are in the final stage for submission.

Manuscript #1

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

H.-H. Hinrichsen, A. Lehmann, C. Petereit, A. Nissling, D. Ustups, K. Hüssy

The spatial distribution patterns of eastern Baltic cod early life stages as well as strong variations of the circulation patterns provide an excellent opportunity to distinguish between self-sustaining components of the different cod stocks and regions of their mixed populations. A hydrodynamic model combined with a Lagrangian particle tracking technique was utilized to provide long-term knowledge on 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 tested the environmental conditions in the different spawning grounds for suitability of spawning, egg survival probability and estimated the population connectivity of eastern Baltic cod eggs and yolk-sac larvae between the different spawning grounds. On general, the extent of cod eggs in the Baltic Sea represented as virtual drifters is determined by the level of oxygen conditions, which define a major habitat requirement to which species' physiology is suited. Secondly, eggs initially released as drifters in the most western spawning grounds were strongly affected by sedimentation, while for the whole spawning environment temperature dependent mortality was only evident after severe winters. The combination of topographic features and egg buoyancy appears 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 (Figures 1-2).

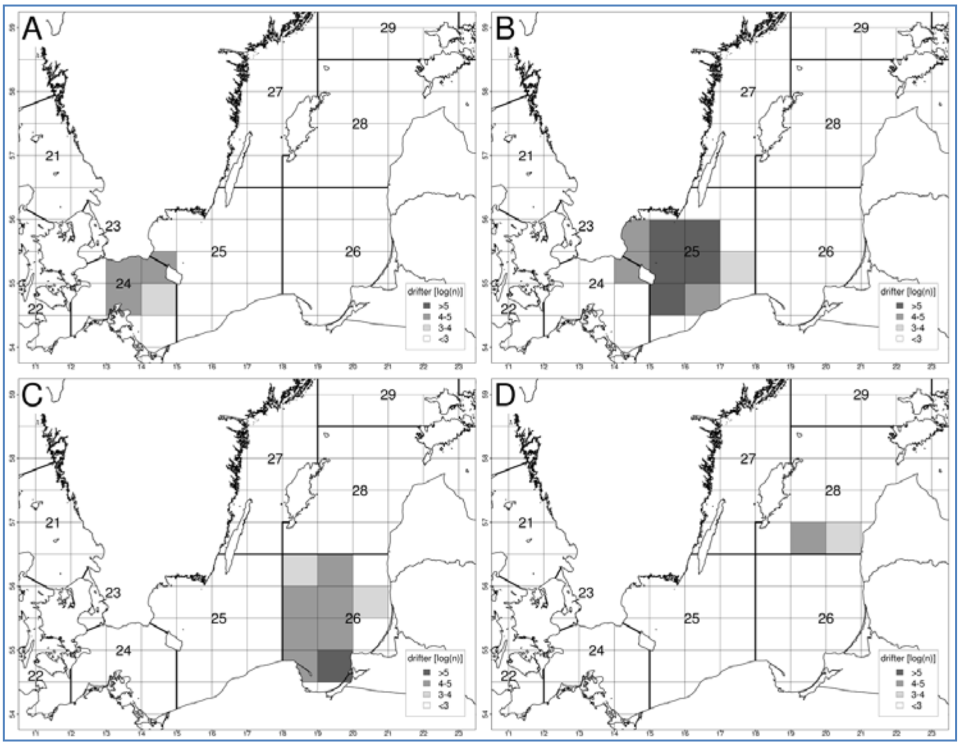

Figure 1. Sum of virtual drifters (1971-2010) representing spawned eastern Baltic cod eggs at spawning grounds in the central Baltic Sea for ICES subdivisions (log_{10}-transfrormed), spawned in a) SD 24, b) SD 25, c) in SD 26, and d) in SD 28.

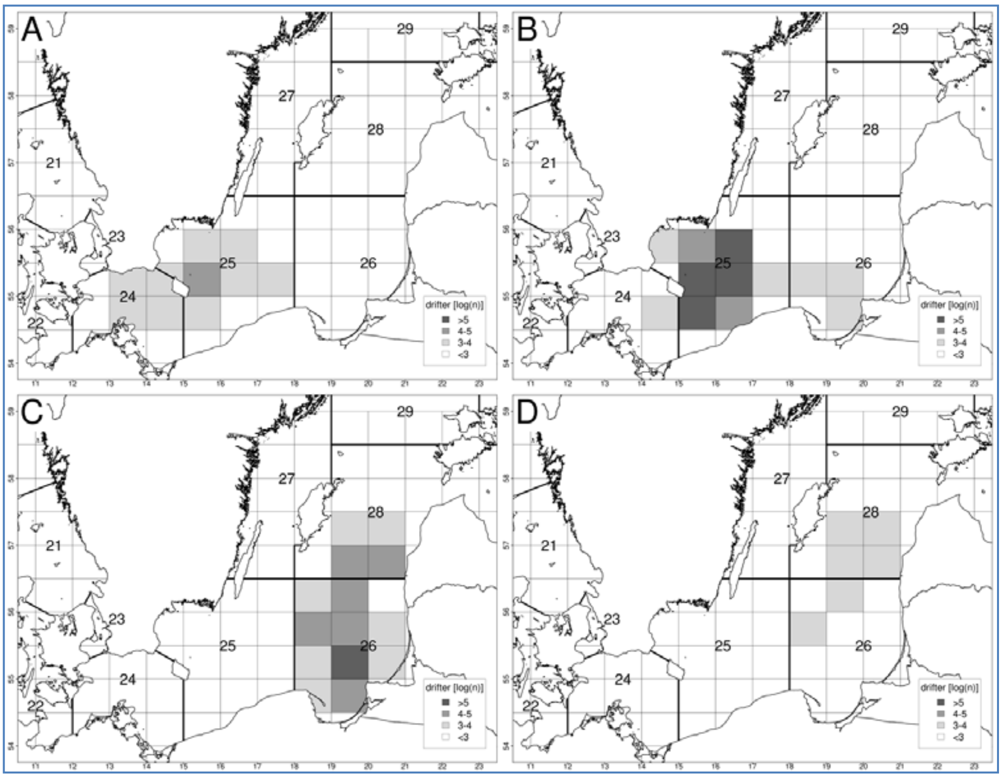

Figure 2: Sum of virtual drifters (1971-2010) representing surviving eggs until the yolk-sac larval stage of eastern Baltic cod in the central Baltic Sea for ICES subdivisions (log_{10}-transfrormed), spawned in a) SD 24, b) SD 25, c) in SD 26, and d) in SD 28.

Manuscript #2

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

K. Hüssy, H.-H. Hinrichsen, M. Eero, H. Mosegaard, J. Hemmer-Hansen, A. Lehmann, Louise S. Lundgaard

In the Baltic Sea, two genetically distinct cod populations occur, the “Eastern” Baltic cod in ICES SDs 25-32 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 recruitment.

Other deliverables (**D2.3 Manuscript (2) on migrations of adult individuals** (clupeid manuscript)**; D2.4 Report on Migration estimates and D2.5 Database on small scale distribution of cod, herring and sprat**) were only briefly discussed at the meeting. For herring and sprat, acoustic data from the BITS surveys have been compiled for 1974 to 2010 by quarter in order to estimate redistribution in spatially explicit population and management models. Several preliminary data analysis are already available and these have been incorporated into D2.1 (submitted and approved). It was agreed that these deliverables will be discussed at more detail at INSPIRE 3rd Integrating Workshop.

Planning activities of Work Package 3

INSPIRE Work Package 3 activities include collecting basic knowledge on regional stressors for population dynamics of Baltic fish populations. The focus is on a quantification of effects transported from regional scale nurseries and spawning grounds to larger scale productivity and spatial distributions. A major challenge is to evaluate the importance of particular retention areas to the total population and to analyze local scale mortality and the impact on higher spatial scales.

1) *Two studies on the Western Baltic herring (P. Polte, D. Moll)*

WBSS herring is an important stock for commercial fisheries in the Western Baltic Sea and accomplishes extended annual migration between their feeding grounds in the Kattegat and Skagerrak and their spawning areas along the shallow coastal waters in the Western Baltic Sea. This herring stock is considered to represent a meta-population composed by multiple spawning components. One of the main components of the WBSS stock is the “Ruegen herring” named after the main spawning area located in the shallow lagoons around the island of Ruegen. Hypothesizing that single nursery areas provide a major contribution to the WBSS herring stock, two questions will be addressed:

1. Which spawning areas provide the most recruits?
2. Which local stressors have an impact on recruitment success?

Pilot study will be conducted in spring 2015 using the method of elemental fingerprinting in herring otoliths. Trace elements incorporated into the growing surface of the fish otolith reflect the physical and chemical characteristics of the ambient water body. The spawning areas along the shallow coastal waters of Mecklenburg West-Pommerania are heavily affected by anthropogenic alteration and with a relatively high diversity of trace metal concentration.

From March to June each year the Rügen herring larvae survey is carried out weekly in the waters of Greifswald Bay, Germany. It provides the only fishery independent metric for recruitment strength of Western Baltic Spring Spawning (WBSS) herring. Weekly data on larval herring abundance, however can potentially provide a quite baseline to investigate habitat utilization of progressing life stages as a response to regional stressors, such as eutrophication or habitat degradation.

2) *Larval herring investigations in the Gulf of Riga (T. Arula et al.)*

The search for environmental fisheries independent predictors of recruitment is at least a century old task in fisheries science. As in most of marine fish species, the regulation of Baltic spring spawning herring year class occurs during the short period of the early life history. Weekly surveys targeting herring larvae, their prey and abiota in a coastal shallow habitats in the NE of the Gulf of Riga revealed a statistically significant strong relationship between the abundance of postflexion larvae and herring recruitment estimates from hydroacustic survey (r^2=0.73) in 2004-2013 (Figure 3). The survival of postflexion larvae was significantly coupled to SST experienced during their life span (r^2=0.69). It seems that seasonal production of copepod nauplii facilitates the survival of first-feeding larvae as exept one year out of ten their seasonal abundance course correlated strongly ($r>0.5$). All distinct life stages: yolk-sac, preflexion, flexion and postflexion showed good consistency between their annual abundances, meaning that neither methodological bias nor difference in net survival affect results. The present study proposes new bottleneck that has not considered so far as potential mechanism regulating the survival of postflexion herring larvae in rapidly warming coastal retention habitats.

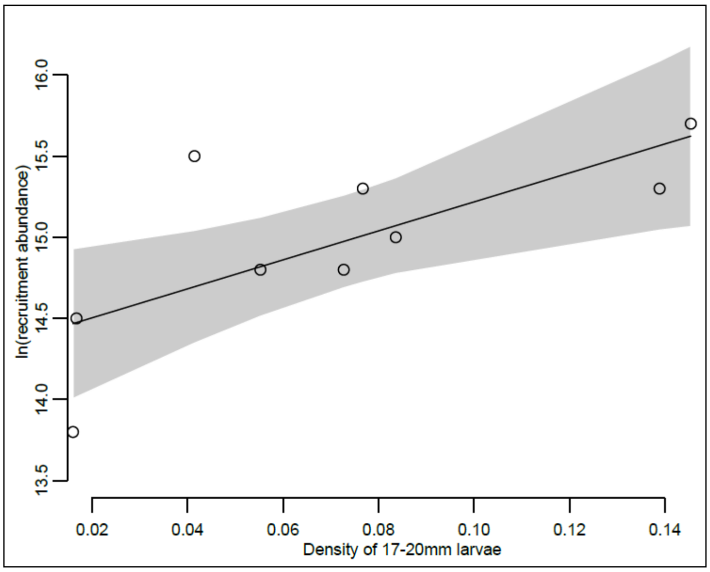

Figure 3. Relationship between the abundance of large larvae and recruitment of the Gulf of Riga herring.

3) *Zooplankton as potential driving force for pelagic fish distributions (H. Ojaveer et al.)*

To start investigating the potential importance of prey field dynamics and variability shaping the clupeid distributions, Baltic Sea zooplankton dataset has been compiled. It contains historical and contemporary zooplankton monitoring data collected by six institutions in Finland, Estonia, Latvia, Russia and Poland between 1957 and 2012. The data have been harmonized for the structural organization of data and species taxonomy, yielding a coherent dataset of ca 23000 zooplankton samplings representing nearly 15000 vertical profiles (Figure 4). Data was split into three regions: *coastal* (near coastal areas with depth < 15m, enclosed bays etc.), *large gulfs* (mostly samples from the Gulf of Riga); and *offshore* (central and southern parts of the Baltic Proper). All sample pairs that were collected within less than 3 months and 100 km apart from each other, with both conditions met simultaneously, were picked out for analysis, along with the spatial and temporal distance between the samples. Altogether 100 000 unique combinations of sample pairs were identified and used from coastal areas; 10000 sample pairs in large gulfs and 6000 sample pairs in offshore region. Some initial results are already available, which may assist to evaluate prey as a driver for zooplanktivorous fish distributions and migrations at various spatial scales. Small copepods, namely *Acartia* spp. and *Eurytemora affinis*, make up the largest fraction of zooplankton biomass. Large copepods show higher biomass values in open Gulf of Riga (*Limnocalanus macrurus*) and in the offshore Baltic Proper (*Pseudocalanus* sp., *Centropages hamatus*). Cladocerans are important in coastal region (mostly *Eubosmina* spp. and *Pleopis polyphaemoides*), and offshore regions (*Evadne nordmanni*, *Eubosmina* spp.). In most cases, the temporal difference between samples affects biomass and abundance differences more than the spatial distance. Only the abundance and biomass of large copepods varied comparably with space and time. In many cases, highest difference in biomass and abundance was found between the samples that were 1 month apart. For large copepods, spatial analysis indicated also highest variation at 50 km distance. The highest temporal variation in both abundance and biomass was found for cladocerans. Analysis also revealed that, if two samples were to be taken in the same place and same day, total zooplankton abundance and biomass could easily differ 1.4-2 times on average.

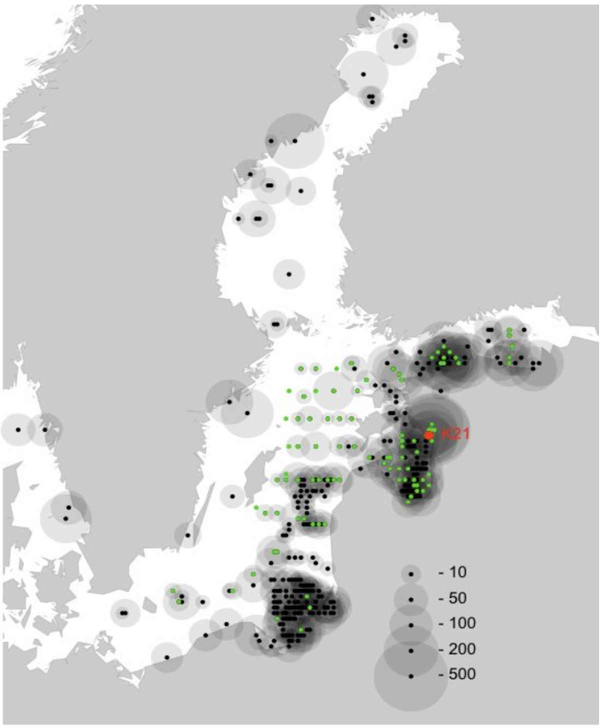

Figure 4. Map of the zooplankton data.

Session #2: Spatial distributions of key species and life-stages

INSPIRE Work Package 1 focuses on understanding the spatial distribution and habitat preferences of the focus species, cod, flounder, herring and sprat. The status of the Deliverables was presented by the WP1 leader. A summary of the status of the Deliverables, together with the data envisaged to be used to tackle them, is presented in the Table below.

A number of presentations addressing the different Deliverables were given. The list of presentations, with the respective short summary of the contents, is presented below.

D1.2 Report on distribution maps for different life-stages (M28).

Swedish historical data for cod and flounder (Alessandro Orio)

The historical Swedish bottom trawl data (1920-1990) was presented together with the spatial distribution of the focus species (cod and flounder). These data will be used to address the Deliverables 1.2 - 1.4, and as input for other Deliverables within INSPIRE.

Use of pelagic survey catches for cod distribution analyses (Michele Casini).

A new approach to use the pelagic control catches from autumn acoustic surveys (BIAS) to study the spatio-temporal dynamics of the cod population was presented. 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). These data will be employed to tackle Deliverables 1.2 - 1.4, and as input for other Deliverables within INSPIRE.

D1.3 Manuscript on simulating spatial distributions of key exploited stocks (M28).

Statistical methods for spatial modeling and examples (Ulf Bergström).

The concept of species distribution modelling and the methods applied for producing maps of species distributions or habitat suitability were described. An overview of different statistical approaches was given, comparing their relative strengths and weaknesses. Ensemble modelling was suggested as a method for combining the outputs of different models. Different applications of species distribution modelling were provided, together with examples from previous modelling efforts directed towards the species in focus within INSPIRE.

D1.4 Report on spatial overlap between predator-prey and competing species (M28).

Why is spatial overlap probably more important than expected? (Stefan Neuenfeldt).

Previous results have indicated that on population level as a consequence of incomplete cod-clupeid overlaps, the ratio of consumed herring to sprat will increase *slower* than proportionate to the ratio of herring to sprat abundances in the sea. This effect increases with decreasing oxygen saturation in the deep water. The oxygen gradient in the deep water affects cod prey-specific consumption rates, and if the ratio of sprat in the sea increases, then the percentage of the sprat stock consumed by cod will, in the absence of compensating behaviours of cod and their clupeid prey, decrease at a rate that is inversely proportional to the cod-herring overlap.

In conclusion, the presented studies showed that decreasing prey-specific consumption rates at increasing prey abundance can occur on the population scale solely due to overlap-dependent spatial variations in prey availability, *i.e.* without the individual predator altering preferences. Furthermore, as overlap changes occur in response to hydrographic fluctuations, predation mediates an effect of hydrographic changes on the prey population dynamics.

D1.5 Manuscript on habitat preferences of different life-stages of fish (M34).

Summary of planned/suggested studies from the different INSPIRE Institutes (Michele Casini).

The amount of data collected during the INSPIRE field surveys allow for tackling the Deliverable from different angles and using different approaches. A list of potential approaches and scientific questions was produced and discussed with the participants. This would hopefully allow a better coordination of the research activities that will be performed with the data collected during the INSPIRE field surveys.

D1.6 Manuscript on spatially explicit population and foodweb modeling (M40).

Spatially explicit population and foodweb modelling – state of the art and where to go from here in INSPIRE (Stefan Neuenfeldt).

Management of fisheries for cod can have an impact on fishing opportunities for sprat and herring, and vice versa. Cod are predatory, and their main prey is sprat and, to a lesser extent, herring and also juvenile cod (cannibalism). Growth of herring and sprat has been density-dependent. The relative distributions of predator (cod) and prey (herring and sprat, juvenile cod) have changed substantially during the last years, and for the time being much herring and sprat are outside the predatory reach of cod.

Preliminary model runs have indicated that the present distribution patterns of cod, herring and sprat imply that an increase in fishing mortality (F) on cod not necessarily will result in increasing Baltic wide clupeid stock sizes. Conversely a decrease in F on cod will not necessarily result in a decrease of the Baltic clupeid stock size if it will not be accompanied by a cod expansion to northern areas. Higher sustainable fishing mortalities for herring and sprat are also obtained when density dependent growth is assumed for the two species, as the stocks compensate by a higher growth at lower stock densities due to either higher fishing mortalities or predation.

The model development will be continued and it was discussed how INSPIRE will accommodate the problems with age-determination if cod by switching to a purely length based approach for the spatially explicit multispecies modelling.

Updates on spatial food web modelling for the Baltic (Stuart Kininmonth).

Understanding the dynamics across the established regime shift observed in the late 1980s requires novel research into the spatial heterogeneity of the key processes. In this project with INSPIRE, the emphasis will be to develop more sophisticated models, based on enhanced field data, that help explore the spatial and temporal relationships. Using a similar set of collected and modeled environmental and ecological data (describing the trophic structure and environmental status) we will develop 2 model approaches in synchrony. The first model described as the size structured mechanistic model is based on mathematically describing the relationships (often based on metabolic theory) across the trophic web. The second model is the development of a spatially explicit Bayesian Belief Network. The first step currently underway is the collection of data spanning many years and relevant to a suite of factors deemed most influential in the dynamics. The next step will be the use of the data to generate conditional probabilities such that a fully working model is constructed. This model will encompass spatial structure, not through isolated instances of the model but through a process of identifying the key spatial drivers of the population interaction. There will be a reliance on the use of oceanographic models coupled to biotic models. An early version of this BBN was shown to INSPIRE Hamburg meeting but this will alter significantly following the data assembling phase and expert review. The final phase will be the comparison and amalgamation of the two models.

	Deliverable	**M**	**Status**	**Data**
D1.1	Database from first surveys to initiate habitat modelling and spatial distribution analyses	14	• Decided how to set up the common database.	INSPIRE field surveys (gillnet and beach seines).
D1.2	Report on distribution maps for different life-stages	28	• Ongoing compilation of the data. • Some maps already	• BITS existing database (DATRAS) • SLU historical demersal trawl data • BIOR historical demersal

			produced - Eggs and larvae distributions (ichthyoplankton surveys 2014). - Large cod distribution (BIAS survey).	trawl data • BIAS/BASS (acoustic surveys) data (BAD1 and control catches) • INSPIRE Ichthyoplankton and acoustic surveys
D1.3	Manuscript on simulating spatial distributions of key exploited stocks	28	Started. • Ongoing compilation of the databases. • Spatio-temporal dynamics of adult cod (BITS survey)	Data from D1.2
D1.4	Report on overlap indices between predator-prey and competing species	28	Waiting data from D1.2	Data from D1.2
D1.5	Manuscript(s) on habitat preferences of different life-stages	34	Waiting data from D1.1	INSPIRE gillnets and beach seines, Ichthyoplankton and acoustic surveys
D1.6	Manuscript(s) on spatially explicit population and foodweb modelling	40	To come, start 2nd project year	
D1.7	Design protocol for future surveys for flatfish and juvenile cod	44	To come, end of the project	

Session #3: Species migrations based on traditional tagging data

Traditional tagging database was assembled and the respective deliverable (D2.1) finalised. This will be basis of two further deliverables: **D2.3 Manuscripts (2) on migrations of adult individuals (M24) and D2.4 Report on Migration estimates (M24).** It was agreed that these deliverables will be discussed at more detail at INSPIRE 3rd Integrating Workshop.

In total, data from 1236 cod recaptures from traditional tagging programmes and 602 records from data storage tags, comprising depth, temperature and salinity every 10 minutes while at large, have been collected in the INSPIRE tagging database. These 1838 recaptures correspond to more than 20 000 originally tagged cod. Preliminary analyses has indicated 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 (Figure 5). Furthermore, the net displacement is independent of the time at large. There is hence no diffusion-like process at work.

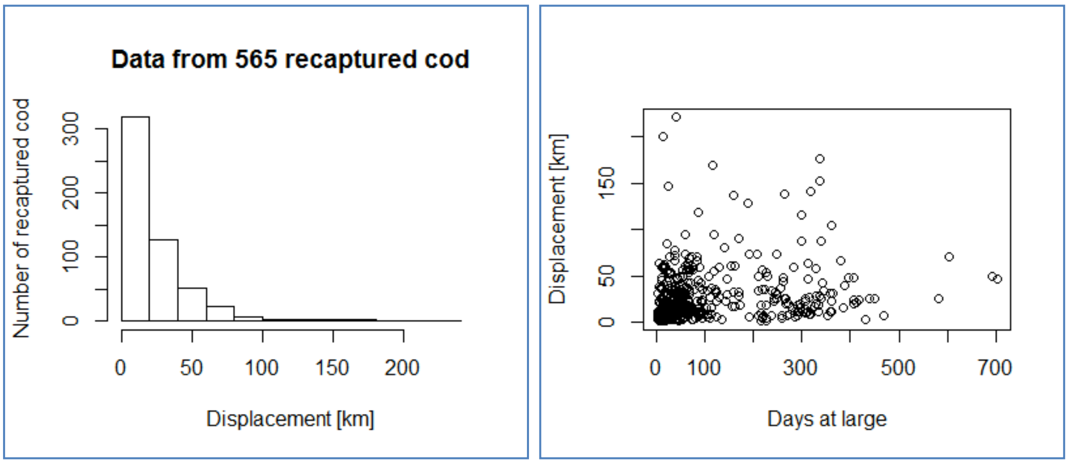

Figure 5. Net displacement data from a sub-set of 565 recapture (left panel); net displacement versus days at large (right panel).

Sub-group work

4.1. Herring review paper(s)

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:

- ✓ 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).
- ✓ 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.

It was agreed to perform this analysis intersessionally and schedule further discussions at the INSPIRE 3rd Integrating Workshop.

4.2 Larval herring study

Herring populations throughout the Baltic Sea reproduce to a great amount in inshore embayments, estuaries and lagoons, where they attach their demersal eggs to benthic substrates. The hatched larvae remain in those retention areas for a significant part of their early life history until the major variability of natural mortality is over. An important task in INSPIRE is to evaluate how herring ecology on the local/basin scale can be extrapolated to the scale of the population. An approach would be to compare the major stressors of herring recruitment between multiple basins along the hydrographic gradients of the Baltic Sea.

To systematically address the spatial ecology and variability of Baltic herring, pan-Baltic larval herring investigation was proposed. It will contribute to achieving aims of WP3 Task 3.2. Thus, it was discussed and agreed that multivariate analysis of drivers and stressors affecting herring recruitment will be carried out. The overarching objective is 'Identification of large scale vs. small scale drivers by analyzing similarities and differences of larval herring dynamics and their response to environmental variables along the Baltic Sea gradients'. Basin-scale environments and biological response variables, such as larval abundance and larval cohort dynamics are planned to be analyzed in multiple basins along the Baltic Sea. This is a novel approach to understand the specifics in herring ecology and hence isolate the drivers affecting recruitment in multiple areas. This is bases on the major hypothesis that herring early life history in the Baltic Sea is subjected to a quite different suite of drivers than stocks in the neighboring North-East Atlantic.

Potential hypotheses to be addresses include:

- ✓ Similarities in biological responses hint on generic drivers of Baltic Sea herring production;
- ✓ Large-scale climate regimes are not dominating over local scale stressors (e.g. eutophication) driving the dynamics of fish and zooplankton communities throughout Baltic Sea gradients and herring populations;
- ✓ Are there are general trends in larval herring dynamics showing clear seasonal shifts from cooler (North) to warmer (South) environment?

The agreed follow-up actions are:

- ✓ All interested INSPIRE scientist to identify and assemble national databases on larval herring;

- ✓ Compile one joint central INSPIRE larval herring database;
- ✓ Based on the available data, revisit the reserach hypotheses prtoposed above, and
- ✓ Schedule discussions during INSPIRE 3rd Integrating Workshop.

Annex 1. Meeting agenda.

Agenda

2nd integrating workshop of INSPIRE

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

Grosse Elbstrasse 133, 22767 Hamburg

Wednesday, 11. February

13:00-13:15	Introduction to **2nd Integrating Workshop** (Christian, Patrick)
13:15-15:00	Session #1: 'Small-scale distributions of cod and clupeid' (Patrick, Henn)
15:00-15:15	*Coffe/Tea*
15:15-17:00	Session #1 (cont.)
19:00	*Common Dinner*

Thursday, 12. February

09:00-10:00	Session #2: 'Spatial distributions of key species and life-stages' (Michele, Ulf)
10:00-10:15	*Coffee/Tea*
10:15-12:00	Session #2 (cont.)
12:00-13:00	*Lunch*
13:00-14:00	Session #2 (cont.)
14:00-15:00	Session #3: 'Species migrations based on traditional tagging data' (Christian, Stefan).
15:00-15:15	*Coffe/Tea*
15:15-17:00	Session #3 (cont.)

Friday, 13. February

09:00-10:00	Work in sub-groups
10:00-10:15	*Coffee/Tea*
10:15-11:30	Work in sub-groups (cont).
11:30-12.00	Wrap up of **2nd Integrating Workshop** and adjourn

Annex 2. Participants list

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