# Studies and Pilot projects for carrying out the common fisheries policy 

## Lot 8: Joint data collection between the fishing sector and the scientific community in the Baltic Sea

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## 1 Executive summary

The scientific assessment of fish stocks requires detailed information on fishing effort of the commercial fisheries, on the catch composition (e.g. discards) and the biological characteristics of the catch (e.g. length and age distribution). These data are usually derived from fisheries logbooks and scientific sampling of commercial catches (e.g. National Fisheries Data Collection Programmes under the EU Data collection regulation - DCR). However, the spatial and temporal coverage of scientific sampling is rather limited due to given restrictions in personal and funding.
As a result, the quantity, quality and reliability of the data, derived from commercial fisheries, are often topic of debates and cause uncertainties in the assessment and the management. The participation of fishermen in the process of collecting relevant data could overcome those problems. The overall aims of JOIFISH/Lot8 ("Joint data collection between the fishing sector and the scientific community in the Baltic Sea") were

- to identify and design new programmes of joint data collection in the Baltic Sea
- to test the feasibility of such programmes
- to present potential ways to incorporate data, derived from self-sampling, into stock assessment.

During the first Baltic Fisheries Dialogue, fisheries representatives and scientists from Western Baltic countries agreed to focus the cooperative work within the framework of JOIFISH/Lot8 on two main topics. With regards to both topics, several sub-projects were initiated and implemented to test their feasibility. All of them were designed in close cooperation with fishery:
topic 1) The collection of additional information from fisheries
a) The implementation of a reference fleet was tested (chapter 3.2.1.1), gathering representative data on the spatial and temporal distribution of its fishing activities, fishing effort and catch composition. The present reference fleet study has revealed that this approach can improve the input data used in the Western Baltic cod assessment. Nevertheless, some effort has to be allocated to ensure a long-term perspective of such reference fleet, e.g. regular training of fishermen and compensation for additional effort.
b) The collection of length data of cod was tested (chapter 3.2.1.2) but proved to be more difficult. The main reason, as stated by fishermen, was the relative low compensation compared to the additional effort. However more compensation may overbalance the scientific benefit.
c) To collect detailed information about fishing activity and catch composition of the Polish fishery, the project "Determining the magnitude of discards in the Baltic cod catches and further actions with regards to them if no-discards fisheries is implemented" was initiated (chapter 3.2.3). Whereas this project has revealed important insights into the dynamics of fisheries in the Baltic Sea and offered an interesting way of data collection, it may be difficult to expand this approach to other fleets.
topic 2) The improvement of the estimation of Western Baltic cod recruitment The estimation of Western Baltic cod recruitment, based on recent scientific surveys, is problematic. Therefore, two alternative strategies to investigate the year class strength of Western Baltic cod were evaluated and tested.
a) A joint cod recruitment survey (CRS) was conducted onboard of commercial fishing vessels (chapter 3.2.2.1). This CRS-approach showed not to be optimal in order to improve the year-class estimate due to several reasons: restricted spatial coverage, difficult to sample at shallow waters, limited temporal coverage. Hence, it was not possible to overcome constrains of scientific surveys.
b) The self-sampling of pound-net fisheries was tested in Denmark in Germany (chapter 3.2.2.2). This passive, near-shore fishery frequently catches small (YOY) cod, whereby the fishing gear is deployed over longer periods (several months) and the sampling frequency is typically relative high at relative low costs. This selfsampling gave promising results and Denmark and Germany will try to continue this program.

As the reference fleet and the self-sampling of pound-net fisheries were implemented successfully, strategies to incorporate data from both programmes into the stock assessment are presented.

Originally, it was planned to set up a common international basis for the selfsampling programmes in the Western Baltic, including joint meetings, joint training etc.. Finally, linguistic barriers hamper such approach (at least) for some German fishermen. Therefore, international coordination meetings between scientist and fishery representatives and national meetings with fishermen may be a good solution.

## 2 Introduction and objectives of the project

### 2.1 Project participants

Project coordinator: Tomas Gröhsler coordination team:

Daniel Stepputtis
Antje Krieger
Ronny Weigelt
Petra Jantschik
Tab. 1: List of project participant, responsible person for each institute is marked (*)

| Name | Country | Institute | Duration | $\underline{\text { Tasks }}$ |
| :---: | :--- | :---: | :---: | :---: |
| Gröhsler, Tomas * | Germany | OSF | $05 / 2007-02 / 2009$ | $1,2,3,4$ |
| Stepputtis, Daniel | Germany | OSF | $05 / 2007-02 / 2009$ | $1,2,3,4$ |
| Krieger, Antje | Germany | OSF | $12 / 2007-07 / 2008$ | 2,4 |
| Jantschik, Petra | Germany | OSF | $07 / 2008-02 / 2009$ | $1,2,4$ |
| Weigelt, Ronny | Germany | OSF | $07 / 2008-02 / 2009$ | $1,2,4$ |
| Storr-Paulsen, Marie * | Denmark | DTU Aqua | $05 / 2007-02 / 2009$ | 2,3 |
| Degel, Hendrik | Denmark | DTU Aqua | $12 / 2007-02 / 2009$ | 2,3 |
| Andersen, Ken Haste | Denmark | DTU-Aqua | application |  |
| Andersen, Michael | Denmark | Fishermen <br> BSRAC | $12 / 2007-02 / 2009$ | 1,2 |
| Vitale, Francesca * | Sweden | IMR | $05 / 2007-12 / 2007$ | 2 |
| Casini, Michele | Sweden | IMR | application |  |
| Walther, Yvonne * | Sweden | IMR | $06 / 2008-02 / 2009$ | 2,3 |
| Karnicki, Zbigniew * | Poland | MIR | $05 / 2007-02 / 2009$ | 2,3 |
| Pelczarski, Wojciech | Poland | MIR | $05 / 2007-10 / 2007$ | 2,3 |
| Bzoma, Szymon | Poland | MIR | $12 / 2007-02 / 2009$ | 2,3 |

### 2.2 The need for collaboration between fisheries and fisheries science

### 2.2.1 Status of cooperative research/cooperative projects prior to JOIFISH/Lot8

(apart from National Fisheries Data Collection Programmes under the EU Data collection regulation - DCR)

Compared to other areas, there are only very few cooperation programmes between fisheries and fisheries science in Western Baltic countries (ICES 2008a). Consequently, JOIFISH/Lot8 was urgently needed and participants had to break new ground. Cooperative projects conducted prior to the start of JOIFISH/Lot8 (in addition to National Fisheries Data Collection Programmes) are listed below:

## Germany

Beside cooperation within the framework of the National Fisheries Data Collection Programme, joint cooperation programmes were rarely conducted. Several commercial vessels were routinely chartered for selectivity studies.
Nevertheless, a joint discard-project was designed and planned between the fishery organisation of the Island of Fehmarn and the Institute of Baltic Sea Fisheries. The resulting "Fehmarn Landing Obligation Study (FLOS)" was planned to start (with some delay) in 2009.
Poland
In the past, there were two projects related to the selectivity of T-90/Bacoma cod ends. The cooperation between fisheries and science with respect to the data collection was limited by the acceptance of scientists on board of vessels to collect biological samples.
Sweden
The institute of Marine research performed a study on bycatches of cod in different fisheries in the early 1990s. This project was carried out as a joint effort with fishermen who allowed observers onboard their vessels. It was mainly pelagic fisheries for industrial and consumption purposes that where investigated (Walther, 1995).
During the last decades a number of gear selectivity studies (Bacoma, gillnet, national studies) have been performed, during which scientists were accepted as part of the crew on board and were allowed to measure the catches. The Swedish Board of Fisheries is presently carrying out an experimental program of co-management in Kattegat. This initiative started in January 2005 and aims to evaluate the possibility for institutionalising regional co-management programs. Commercial and recreational fishermen, researchers, local and regional governments, water owners and other relevant stakeholders organize meetings in order to identify problems, discuss solutions, agree on action plans and make proposals for changes. A survey, with cod as target species, in Kattegat on board of commercial boats, is already planned (within the project Lot3) and was conducted in October 2008.
Denmark
Recently, REX 1 (2005-2008) and REX 2 (2006-2008) projects were focusing on cod distribution on different sea floor types. The project was initiated by the industry as they questioned the station-allocation applied in the North Sea cod
survey (IBTS). The investigation is conducted by three commercial vessels with scientific staff on board.
The sole survey in Kattegat is a joint survey of fishermen and scientists and has been conducted since 2004. The industry has been involved in selecting the gear, time of the survey and $40 \%$ of the station allocation. The survey is conducted on 2 commercial fleets with scientific staff on board. A survey, with cod as target species, in Kattegat on board of commercial vessels, was started in December 2008 as well.
In addition, several commercial vessels have been chartered for gear specific studies. The most recent study was a Norway pout experiment, were the discard level was reduced with sorting grids. This project was initiated by fishermen.

### 2.2.2 Scientific demand for better data

The assessment of fish stocks is often hampered by poor data quantity and quality as most of the data used in current stock assessments derives directly from commercial fisheries. The knowledge of key aspects, such as effort data, catch composition, bycatch and discards is rather poor. Additionally, some data cannot be delivered either by the commercial fisheries or by research cruises within current sampling strategies. Information on recruits, for example, is scarce, yet recruitment data are essential to predict stock dynamics in a short-term forecast. Therefore, it is necessary to combine the knowledge of fishermen and scientists to enhance the quality of the assessment, strengthen the reliability of the assessment and eventually improve the fisheries management.
The need of better cooperation can be illustrated by looking at the assessment of the western Baltic cod. The tuning of the western Baltic cod VPA assessment is based on scientific surveys data from the Danish RV "Havfisken" and the German RV "Solea". At present, one commercial tuning series has been introduced since the assessment (WKROUND 2009), the Danish trawlers. The Danish logbooks deliver the effort estimate as days at sea and catch as total landings of target species from the entire trip. This gives a rather rough estimate of the actual fishing effort, especially since no information is available from this data source concerning the proportion of the days spent for fishing and about the proportion of discards. Therefore, effort estimates based on the actual time spent for fishing and information on discards provided on haul-by-haul basis would improve the precision of input data for the assessment. Furthermore, detailed information about the geographical position, instead of the presently used spatial resolution limited to the ICES-square, would improve our knowledge on the location of spawning and feeding aggregations. Although VMS data has improved our knowledge on the spatial resolution it is still less than $50 \%$ of the total fleet in the Western Baltic were VMS is mandatory. Additionally, joint data collection could help to give a more reliable estimate for misreporting, especially if applied to Eastern Baltic Sea fisheries (which was not the focus of this study).

### 2.3 Scope of the study

The main aim of the study was to review, design and test the feasibility of new joint data collection programmes improving the data quality for fish stock assessments and fisheries management in a cost-effective way and involving the fishing industry more actively in the scientific process leading to the provision of scientific advice. A secondary objective - and an important one for the success of the project - was to build trust between the fishers and the scientists. The trust building was facilitated through cooperation on the main content of the project and through close cooperation during the implementation.

The main objectives were to bring together fishers organisations and scientific fisheries institutes to collate, analyse and interpret the information gathered by fishermen, or more concretely:

- to develop and evaluate strategies for e.g. sampling of i) fisheries data (e.g. catch composition and effort distribution), ii) fish stock data (e.g. abundance and stock structure), and iii) environmental data onboard fishing vessels
- to conduct feasibility studies demonstrating how the obtained information can be integrated into fish stock assessments
- to proof the concept by test trials in-situ, i.e. conduct tests on fishing vessels
- to evaluate the suggested concepts together with stakeholders in order to ensure coherent data gathering, interpretation and quality assurance

The work programme was broken down into three work packages (WPs) and four tasks:

## Work packages

1) Selection and design of specific programmes
2) Implementation
3) Evaluation

## Tasks

1) Organisation of workshops
2) In situ implementation of programmes
3) Implementation of programmes into assessment procedures
4) Coordination

The structure of the report follows the definition of the different tasks.

## 3 Tasks

The project is organised around four major tasks:

1) Organisation of workshops;
2) In situ implementation of programmes
3) Implementation of programmes into assessment procedures
4) Coordination

### 3.1 Task 1: Organisation of workshops

Responsible partner: Institute of Baltic Sea Fisheries Rostock - OSF (Germany)
"It is important that the decision of which programmes to be addressed is taken as a collaborative effort by the scientists and the fishers. The representatives of the fishers ensure that the programme is practically feasible, and the scientists will judge the utility of the data which is collected in improving the assessment. The discussions leading up to this decision will be taken during the design workshop: " $1{ }^{\text {st }}$ Baltic Fisheries Dialogue", involving representatives from the different fisheries (e.g. demersal, pelagic trawls and gillnets with different mesh sizes targeting cod, flatfish and clupeids) and the different nations. The evaluation workshop: " 2 nd Baltic International Fisheries Dialogue" will evaluate both the feasibility of the in situ implementation and the success of the procedures for enhancing the stock assessments." (from application)

For detailed information about the workshops, please refer to chapter 6 (Annex 1)).

### 3.1.1 " $1{ }^{\text {st }}$ Baltic Fisheries Dialogue" Introduction

The fundamental step during the planning phase was the "1 Bt Baltic Fisheries Dialogue" ( $1^{\text {st }} \mathrm{BFD}$ ). As indicated in the project application, the meeting was scheduled for June 2007 (assuming a start of the project in January 2007 as stated in the call for tender), i.e. at month 5 of the project. This entailed the chance of an intensive phase of preparation and evaluation of possibilities prior to the meeting. Although the project start was postponed to May 2007, the $1^{\text {st }}$ BFD was held on schedule (due to logistical reasons) on $20^{\text {th }} / 21^{\text {th }}$ of June 2007 at the Federal Research Centre for Fisheries/Institute of Baltic Sea Fisheries in Rostock (OSF, Germany). The late start of the project reduced the preparation time to roughly one month. Therefore, the scope of the meeting had to be adapted from 'final discussion of co-operation programmes to a kick-off meeting, "brain-storm"-event and informal communication platform between fisheries and fisheries science. Therefore, the official part was integrated with social events, which are essential for "breaking the ice" and allowing more open discussions between fishermen and scientists.

Fishermen representatives, few fishermen and fisheries scientists from all Western Baltic countries (Denmark, Germany, Poland and Sweden) joined the meeting. Additionally a representative of the Federal Agency for Nature Conservation (Germany) and representatives of the Ministry of Agriculture, Environment and Consumer Protection of the German federal state of Mecklenburg-Western Pomerania attended the meeting.

The initial presentations about JOIFISH/Lot8 and other aspects of cooperative work were given at the first morning of the meeting. This time schedule allowed further discussions during the meeting based on these presentations, which covered cooperative work in general (D. Stepputtis) and some examples for successful ongoing cooperation such as the Dutch self-sampling programme and the Norwegian reference fleet (D. Stepputtis), as well as one of the very few examples from project participants, the Danish experiences (H. Degel and M. Andersen). Descriptions of these self-sampling programmes can be found in ICES 2007 and ICES 2008a.
Additionally a brain-storm/planning sub-meeting was conducted to discuss Lot8related targets of fisheries and fisheries science and finally to agree on some specific terms of reference for cooperation within JOIFISH/Lot8.

## Results

As stated above, the meeting was an informal platform initiating discussions between fisheries representatives and fisheries scientists. Therefore, this meeting was an excellent occasion to discuss problems related to fish resources in the Baltic Sea in a constructive manner. Beside some smaller co-operations on national level, the meeting participants agreed to work on two major projects/problems, which reflected the needs of fishermen and the needs of assessment scientists:
a) Recruitment of cod in the Western Baltic Sea: This topic was intensively discussed during the meeting. The basic problem seems to be the uneven perception of actual cod recruitment. On the one hand, scientists ascertain from their analyses that recruitment of Baltic cod is still rather poor (with the
exception of 2003). On the other hand, fishermen assert that they see large amounts of recruits and that, given the high proportion of adults they catch, obviously the recruitment must be rather good. Following points have to be targeted:

- discussion and investigation of possible reasons for this non-matching perception of recruitment (e.g. insufficient spatial/temporal coverage of recruits sampling by research vessels, unaccounted high numbers of recruits in commercial catches which are discarded and thus not included in the calculation of VPA/XSA, etc.)
- one suggestion to solve this problem was a joint survey, which investigates possible reasons for the different perception and helps to overcome underlying problems
b) Collecting additional information from fisheries: Fisheries (assessment) scientists stated, that the knowledge about fishing activities is rather limited, which results in (often high) uncertainties in the assessment. This in turn results in frustration and/or non-acceptance of the assessment's results for stakeholders. To address these problems, we have discussed several potential programmes:
- detailed logging of spatial/temporal distribution of the fishing activity
- better determination of the species composition in trawl catches (landings and discards)
- feasibility test of a reference fleet (e.g. following the Norwegian example)


### 3.1.2 " $2^{\text {nd }}$ Baltic Fisheries Dialogue"

The " 2 nd Baltic Fisheries Dialogue" was initiated and funded by the EU funded project JOIFISH/Lot8. The meeting was hosted by Institute of Marine Research in Sweden and held at the Country Administrative Board in Karlskrona, Sweden. Representatives from the fishing industry, fishermen and scientists from Sweden, Denmark, Poland and Germany used this meeting as informal platform to present new knowledge and discuss the status quo, further activities and results of the project JOIFISH/Lot8.
As for the First Baltic Fisheries Dialogue Meeting, additional sessions were held to attract a broader range of participants and to set up a basis for upcoming meetings beyond JOIFISH/Lot8. Further sessions at the meeting were "Traceability and Fully Documented Fishery" and "New Management Strategies". The sessions at this workshop were held in plenary to gain a broad overview of the activities to all participants. JOIFISH-related aspects were discussed under a variety of aspects not exclusively by JOIFISH-participants.

Session1: „Joint collection - away to help each other?"
An introductory overview about the activities and first results of the EU funded project JOIFISH/Lot8 "Joint data collection between the fishing sector and the scientific community in the Baltic Sea" was given by Petra Jantschik (Germany).

A further important aspect of JOIFISH/Lot8 is the design and implementation of a cooperative survey with fishermen and scientists together on commercial fishing vessels (presented by Ronny Weigelt). Additionally to the surveys in Germany, a Cod Recruitment Survey will also take place in Sweden.
Furthermore, a new fishing method for recording cod recruits in shallower water (> 20 $\mathrm{m})$ was tested since autumn 2008. This method includes the passive fishing method with pound nets (chapter 3.2.2.2). According to a protocol, which was developed within JOIFISH/Lot8, fishing data (meta data and catch data) and meteorological were collected directly by the fishermen. Additionally, small cod were sampled by fishermen regularly for further analysis in the institute.

The imperative for the establishment of a feedback information system was very embraced by all participants of the $2^{\text {nd }}$ BFD (Daniel Stepputtis). In order to be able to react better and faster to ad hoc and unexpected events at the sea, a formalized information pathway is necessary. Such events could be changes in spatial distribution, high recruitment etc. A good working example of such cooperation between Fishery and Fishery Science is the Norwegian Reference Fleet.
The information pathway in countries participating in JOIFISH/Lot8 is less formal and structured. Nevertheless, in Sweden meetings between fishery representatives and scientists take place on a regular basis (every two or three month). These meetings are organised in special workings groups (e.g. pelagial or demersal). In Germany similar meetings take place several times per year, whereas these types of meetings do not occur in Denmark. The exchange of information is only personal level and not further structured. Nevertheless, those meetings with fishery representatives do not substitute a (structured) direct information pathway with fishermen.

In order to express the interest of the scientists in such information and the importance of a proper flow of information, fishery representatives suggested that this demand should be published in fishery magazines. It was also underlined that a trustful atmosphere is very important to get this kind of information. The role of certain persons as „door openers" are emphasized. A way to establish such information system could include the following linkage:
Information from fishermen to fishery organisation - fishery representatives scientists on national level - scientists on international level.
Additionally, for specific questions questionnaire-surveys were recommended by participants. For instance, the assessment of changes of the spatial distribution of single species prior to surveys (e.g. hydroacoustic surveys) could help to adapt the area coverage of the survey and therefore to improve results.

## Session 2: "Traceability and fully documented Fishery"

Traceability and fully documented activity of the fishery is a subject, which gains more and more interest to consumers and to the management system.

To increase the sustainable exploitation of the cod stocks in Denmark a project to minimize discards was implemented in 2008. The goal was to setup incentives for the fishermen to change behaviour and avoid discarding. The core of this project is a video monitoring system. The project was presented by Marie Storr-Paulsen (Denmark). The camera system, which has also been used within Canada's long line fishery for several years, was installed on 6 vessels. All landings and discards are documented during the whole fishing trip. All participating vessels have been appointed an extra quota, however the quota is taken from the total catch (including discard). This gives an incentive for the fisherman to minimize the discard as this gives the opportunity to increase the marketable proportion of the quota when only cod above landing size is caught. On the other hand, high amounts of discards (which are charged on the quota) will result in a smaller marketable proportion of quota. Beside electronic log book data, VMS data are used for the evaluation.

A short overview about the scientific use of VMS data was given by Sweden (Mattias Sköld).

Finally, a backtracking/traceability system was presented by Alex Olsen (Danish company Espersen Trading). Interesting aspects were the technical realization of the system (handhelds to enter the data onboard etc.) and the dataflow.

A simple fisheries management system based on TACs and quotas is increasingly considered insufficient to ensure a sustainable use of the resource. Alternative management approaches are necessary to ensure a sustainable use of living resources in the sea.
Christopher Zimmermann has presented some possible approaches, such as:

- Effort management (days at sea)
- Landing obligations (different fisheries)
- Marine Protected Areas
- ITQ - (right based management)
- Ecolabelling (marine stewardship council)
- Traceability and more precise areas

As a working example Kim Kær Hansen, the chair of the Danish fishermen's organisation, gave a short overview about the fishing system in Denmark. Every Danish fisherman is listed at the internet under http://fd.fvm.dk/Fiskeristatistik with his own quota. The responsibility for the management is taken by the fishermen under the new Danish individual quota system.

As expected, the presentations in this topic lead to intensive and constructive discussions between participants.

### 3.1.3 Future of the Baltic Fisheries Dialogue

As stated above, the meetings were an informal platform initiating discussions between fishermen, fisheries representatives and fisheries scientists. Therefore, this kind of meeting was an excellent occasion to discuss problems related to fish resources in the Baltic Sea.
All participants agreed, that the meeting in its present form, as an informal and constructive discussion forum, should be continued. While funding by JOIFISH/Lot8 project is no longer available, the $3^{\text {rd }}$ Baltic Fisheries Dialogue meeting is scheduled for autumn 2009. The host will be Danish DTU-Aqua National Institute of Aquatic Resources and the Danish Fishermen Organization. Thereby a higher participation of fisheries representatives would be preferable

### 3.1.4 Trust building actions

JOIFISH/Lot8 aims to establish a better dialog between the fishery and fisheries science in the whole Western Baltic Sea. It seems obvious, that this work needs a solid foundation of trust between stakeholders. Beside direct contact between scientists and fishermen, several events within the framework of JOIFISH/Lot8 aimed for this topic. Some examples are given below:

## Germany

The Institute of Baltic Sea Fisheries hosted two events which brought together German fisheries organizations and scientists.

- The "Round table" ( $10^{\text {th }}$ October 2007 and $21^{\text {st }}$ May 2008) was designed as informal communication platform (comparable to Baltic Fisheries Dialogue, but on a national level).
- An event, called "Praxis-Wissenschaft" (28 ${ }^{\text {th }}$ June 2007, $26^{\text {th }}$ March 2008) was organized by the German fishing industry and hosted at the Institute in Rostock. Aim of this meeting was to inform fishery and processors about the recent ICES assessment and advice directly from scientists, whereby the discussion of the results and clarifications of problems were central parts of this event.
Additionally, JOIFISH/Lot8 scientists visited several fishery organizations and fishermen and participated in several fishery related meetings and conferences in order to present the project, to find participating fishermen and to ask for help during the planning and implementation phase.

In general it has to stated, that the communication between fishery and science was significantly improved within the framework of JOIFISH/Lot8. This new basis of trust is very helpful for the work in other projects, as well (e.g. DCR).

## Poland

In Poland several meetings with fishermen were held to discuss the necessity of collecting reliable data on CPUE, real level of catches as well as other parameters necessary for high quality stock assessment. Finally fishermen agreed to take part in a new project during which data on discards, CPUE, total catch level as well as biological parameters will be collected, recorded and officially used (for more details, please refer to chapter 10 / Annex 5).

## Denmark

The Bornholm Fishermen's Association hosted a dialogue meeting the $16^{\text {th }}$ October 2007 between local fishermen, the fisheries department and the Danish Institute of Fisheries Research. Marie Storr-Paulsen presented how data are used in the assessment and why it is of great importance to improve these data. Jørgen Eliasen from the Danish Fisheries Department informed the fishermen about the progress of electronic logbooks and how more detailed information can be obtained from these elogbooks. Thereafter, there was a discussion on data quality and how new information from fishermen can improve the stock assessment.

Additionally, the Danish Institute of Fisheries Research hosted two meetings with the Fishermen's Association the 8th of September and the $6^{\text {th }}$ of December 2007 where the reference fleet and the recruitment survey were key topics.
The $30^{\text {th }}$ of January 2009 the institute hosted a meeting on the Norwegian reference fleer, presented by Kjell Nedreaas, IMR with a following round table discussion. The fishery department, fishery ministry and the Danish fishermen organization were invited to the meeting.
The $6^{\text {th }}$ of February a meeting between DTU-aqua and the Danish fishermen's organization resulted in an agreement of 2 annually regular meeting, to have a platform were cooperation and data can be discussed.

## Sweden

The Institute of Marine Research is constantly working on trust building activities. Mostly as giving information on ongoing scientific projects, updating local fishermen on current advice from ICES and helping to interpret scientific matters.
For the area involved in JOIFISH/Lot8 most activities has been directed from the regional office in Karlskrona and the interest for information on local level from the fishermen is very high, and sometimes hard to meet due to other obligations. Scientific staff tries to participate in the local annual meetings arranged by the Fishermen's organisations and other related activities.
As a recent activity the County Administrative Board in Blekinge has formed a group with local young fishermen where a wide an informal discussion about fisheries related science and advice can be held. The wish from the participating scientist is to create small apprehensible lectures on key issues in fisheries science.
Representatives of the Swedish Board for Fisheries and JOIFISH/Lot8 participants are in regular contact with Swedish fishery representatives and members of the Baltic Sea RAC (BSRAC). Officially announced for 2008 are 3 meetings between Swedish Board of Fisheries /Lot8 and fishery: a) with Swedish Baltic RAC members regarding cod fishery, b) with Swedish Baltic Sea RAC members regarding the pelagic fishery and c) with coastal fishermen from southern Sweden.

### 3.1.5 Cooperation with Baltic Sea Regional Advisory Council -BSRAC

The importance of co-operation between fishermen and scientists was addressed shortly at the BSRAC executive meeting in Riga, Lettland in June 2009.
It was very welcomed by the RAC members and the JOIFISH/Lot8 project was mentioned as a welcome new concept.
The chair of BSRAC, Reine Johansson was invited to the $2^{\text {nd }}$ BFD meeting in Karlskrona, but sent a message that he regretfully was occupied at the date of the meeting. The chair of the demersal group in BSRAC Michael Andersen participated in the $1^{\text {st }}$ BFD meeting. The chair of the Danish fishermen's organisation Kim Kær Hansen participated in both BFD meetings.
From the Commission also invited to the $2^{\text {nd }}$ BFD were Poul Degnbol, Olle Hagstroem, Reinhard Priebe, and Stefanie Schmidt, but they were all unfortunately pre-occupied.
The chair of the demersal group in BSRAC Michael Andersen was involved in the project from the very beginning (subcontractor of DTU-Aqua)

### 3.2 Task 2: In situ implementations of programmes

Responsible partner: Institute for Marine Research - IMR (Sweden)
"The programmes will be implemented on selected fishing vessels preferably from all of the four involved nations. Focus will be on establishing the sampling on few, but representative vessels, to keep the costs down. The main goal is to establish a "proof of concept" of the sampling procedure, and identify problems that have to be overcome if the procedure is to be scaled up to a larger fleet. To facilitate the implementation a part of the budget for each partner has been set aside for investment in additional gear, computers, software or fuel and for compensation to the fisherman" (from application)

As stated in chapter 3.1.1 during the $1^{\text {st }}$ BFD fishery and science agreed on two subprojects
a) the collection of additional data from commercial fishing vessels (chapter 3.2.1)
b) investigation of alternative approaches for the estimation of recruitment indices for Western Baltic cod (chapter 3.2.2)

The Polish contribution to JOIFISH/Lot8 was the Research project "Determining the magnitude of discards in Baltic cod catches and further action with regard to them if no-discard fishery is implemented" (chapter 10 (Annex 5)).

### 3.2.1 Self sampling

## Background/Introduction

As mentioned in chapter 2.2.2, an improvement of quantity and quality of input data is essential to reduce uncertainties in the assessment of Baltic fish stocks. In particular, data on fishing effort and its spatial and temporal distribution, as well as detailed data about the catch composition are required. Consequently, fishers and fisheries scientists agreed during the $1^{\text {st }}$ BFD to give high priority to this topic (see chapter 3.1.1).
As most assessment data are derived from the commercial fishery (directly and indirectly) and due to the given (effort-) limitations of recent scientific observer programmes, the direct involvement of fishermen within the process of collecting needed data seems to be obvious. A classical approach is the self-sampling by fishermen (e.g. the establishment of so called reference fleets).

There is an ongoing effort worldwide to develop programmes to use fishers to selfsample their catches (ICES 2007; Johnson and Densen 2007; ICES 2008), since this way of sampling is an efficient and cost effective method to collect fishery data. Additionally, the temporal, spatial and metier coverage could be improved significantly compared to exclusive sampling by scientific institutions.

ICES (2007) and Johnson and Densen (2007) stated that six key points are of major importance for designing and implementing a self-sampling programme: creating incentives for fishermen, communication, confidentiality, survey design, training and financing.

The proposed study shall demonstrate the possibility and advantages/ disadvantages of an extension of recent observer sampling programmes with the direct involvement of fishermen within the process of collecting data for fisheries management/assessment. The sampling schemes should not be static but shall be adapted to prevailing conditions (demands from practical point of view and scientific demands).

The self-sampling in JOIFSH/Lot8 is based on a 3-step approach, whereby each step results in a dataset, which is useful for the assessment of Baltic cod:

1. acquisition of effort data using more detailed logbooks
2. detailed sampling of catch: catch composition (incl. landings and discards)
3. detailed sampling of catch: length distribution of cod (unsorted catches)

Steps 1) and 2) are discussed in chapter 3.2.1.1, step 3) will be covered in chapter 3.2.1.2).

An essential part for self-sampling was to find fishermen who were willing to participate as volunteers for self-sampling. Whereas, fishermen were predominantly contacted at national level, common approaches were used:

- Discussions with fishery representatives and fishermen during the "First Baltic Fisheries Dialogue meeting" ( ${ }^{\text {st }} \mathrm{BFD}$ ) in June 2007 in Rostock. This informal and constructive meeting was an excellent platform to get access to the
fishery and to discuss the setup of joint research. After the meeting, several fishery representatives presented the outcome of the $1^{\text {st }}$ BFD to their fishermen to seek for participants.
- Several articles about JOIFISH/Lot8 and its different topics as established during the $1^{\text {st }}$ BFD (reference fleet and cod recruitment) were published in fishery journals in order to reach the further attention of fishermen (e.g. "Fischerblatt" (Germany) 2007/09 and 2008/08; "Fiskeri Tidende" (Denmark) 20.09.2007). Unfortunately, the feedback was not overwhelming.
- Scientist where invited to meeting of fishery organizations to give a presentation on the project (scientific goal, strategy to reach this goal, potential output and benefits).

The direct and personal contact via different stakeholders (e.g. fisheries representatives, fishery control and fishery masters) was finally the best way to in cooperate some fishermen for the purpose of the self-sampling.

The framework for the implementation of the reference fleet in Germany, Denmark and Sweden was coordinated between the participants. This included a common sampling strategy, which resulted in (a) sampling instructions and (b) protocols (translated into national languages)
a) sampling instructions

At the beginning of the cooperation the scientific staff participated in fishing trips to introduce the scientific scope of the self-sampling scheme. In this close and open dialogue, general instructions for the reference fleet were developed (chapter 7/Annex 2). The instructions for the reference fleet were organized in few short manuals

- The "General instructions for self-sampling on board commercial fishing vessels" (chapter 7.1) gives an overview about the information, which is needed to be recorded.
- The "Instructions for discard acquisition" (chapter 7.3) gives a description on how to estimate the amount of discard under various conditions (gillnet vs. trawl, low amount of discard vs. high amount of discard)
- The "Instructions for biological sampling - length measurements" (chapter 7.4) explains in detail when and how a length measurement has to be carried out.
b) common protocols

According to the sampling strategy and sampling instructions, protocols (trawl and gillnet) were developed to be used within the reference fleet. (chapter 7 / Annex 2). These protocols contain detailed information about

- fishing activity (date, time, exact position, trawl speed, water depth)
- gear type (selection device, mesh size, size of the gear)
- weather conditions (wind direction, wind speed, wave height, precipitation)
- total catch (landings and discard per species)
- others (e.g. for bycatch of birds and mammals)

Whereas the overall sampling strategy was coordinated between Denmark, Sweden and Germany, the implementation of the self sampling programmes (reference fleet and length measurement of cod) by the different participating countries differed to
some extent (number of vessels, period of implementation). These differences will be discussed below.

The data quality was assured by training of the involved fishermen and by regular communication/visits. The fishermen stood in close contact with the scientists, which gave the chance to discuss present problems.

### 3.2.1.1 Reference Fleet

### 3.2.1.1.1 Background/Introduction

Successful examples for reference fleets in Northern waters are the Dutch demersal self-sampling programme and the Norwegian reference fleet. The latter was the most advanced approach presented during the WKUFS-meeting in 2007 (ICES 2007\{2678\}) and WKSC-meeting in 2008 (ICES 2008\{2677\}). Interesting aspects of this Norwegian reference fleet were:

- Representativeness: the involvement of fishermen from different fisheries and many Norwegian regions
- Very good training of participating fishermen: Fishermen are trained to sample their catch both in a simple (length, weight, species composition etc.) and in a more advanced way (e.g. otoliths, stomach, genetic samples, tagging, contaminant samples)
- Financing (in a nutshell): The programme is self-financed by a limited extra catch quota, which is a part of the Norwegian national quota. Fishermen are paid from this budget for their sample effort. Additionally other project costs, such as equipment (e.g. expensive electronic scales and length measurement boards) are covered by this 'research and surveillance quota'.
- Ad-hoc-investigations: Since research vessels have to be booked in advance, ad-hoc investigations of unexpected events (e.g. occurrence of large numbers of juveniles in some areas) can rarely be covered by scientific surveys. Given the excellent training of participating fishermen, the reference fleet can be used for such investigations.

The most important lesson from this Norwegian reference fleet is that trust-building actions, a long-term finance strategy and a good training of fishermen are the prerequisites for a successful implementation of a reference fleet and for the collection of data series long enough to be included into the stock assessment (also stated by Johnson and Densen 2007). Therefore, the Norwegian reference fleet represents a good (long-term) model to follow when to build a Baltic reference fleet.

There are two key issues, which are targeted by a Baltic reference fleet:
a) The collection of effort data time series, which can be used in conjunction with survey data as commercial catch per unit effort (CPUE) tuning series in the assessment. At present, recent estimates are based on trips and are solely available for two Danish fleet segments. Furthermore, due to a shift in the Danish fishing regulation system in 2007, it is difficult to compare the tuning series before and after 2007. Before 2007 the quota was provided as 14 days rations, which were continuously adjusted to the amount of quota left, particularly around the end of the year. After the $1^{\text {st }}$ of January 2007 this system changed to rather complex right-based system (FKA- Vessel Quota Share), where a yearly share of the quota are allocated to fishermen, and these can subsequently trade it, exchange it or pool it with other fishermen's quotas. Fishers are of course still assigned to usual EU-regulations such as closed seasons and fishing days. But first evidence shows that this radical change in the management system has important impacts on fleet structure, effort and fishing patterns, thus changing significantly the CPUE trends. This
implies that the Danish effort tuning series will not be comparable in 2007 with former years. Therefore, the establishment of new effort tuning series is important for the Western Baltic cod assessment.
b) Reduction of uncertainties in the assessment of Baltic cod stocks with improved knowledge of catch compositions (landings and discards), as well as biological characteristics of caught species.

One of the main problems of self-sampling/reference fleets is the understanding that there is a significant time gap between the start of a time-series and its first usage in the assessment. This has to be communicated carefully to the fishing industry.

### 3.2.1.1.2 General Implementation

The basis for the implementation of the reference fleet was the development of a sampling strategy and referring protocols, as described above.

The workload for participating fishermen increased, especially in the trawl fishery with significant possible amounts of discards. Nevertheless, all fishermen agreed to work without any financial incentives in the context of a feasibility study, In Sweden it was very difficult to implement the programme without any funding.

### 3.2.1.1.3 Germany

## Establishing contacts to fishermen - selection of fishermen

The contact to the fishermen was established by the following initiatives:

- contacting fishermen, who already worked with scientists: Uwe Breese (SAS 29);
- contacting fishery organisations: Phillip Deiterding (GRO 7); Gunnar GerthHansen (BUR 6); Dirk Jaudzim (BUR 15)
- participation in different fishery related meetings and conferences: Jürgen Krieger (DRA 004); Lutz-Peter Schluckner (SAS 110)

Many fishermen expressed their interest to participate in the reference fleet. Since a feasibility study requires an intensive support and close dialogue for the design and the implementation of the concept, the reference fleet was only limited to 6 fishing vessels (Tab. 2). Nevertheless, more fishermen tested the sampling scheme and the protocols (Tab. 3).

## Setup of German Reference Fleet

For the German Reference Fleet 3 trawlers and 3 gillnetters (Tab. 2) were selected. As it was aimed to test the feasibility of the reference fleet on different types of vessels and for different fisheries, the selected vessels were a good representation of the German fishing fleet activities. Most vessels exclusively operated in the Western Baltic Sea (ICES Subdivisions 22-24). SAS 110 "Westbank" operated during summer time in the North Sea (no data where gathered during this period).


Fig. 1: Location of home ports of the German reference fleet
The reference fleet activities started in June 2008 following the general guidelines.

Tab. 2: List of participants of German Referenz Fleet (GRF)


Tab. 3: Fishing vessel with interest in JOIFISH/Lot8

| call sign /name | EU-identification | captain | homeport | vessel length (m) | gear |
| :---: | :---: | :---: | :---: | :---: | :---: |
| LAU11 "Gadus" |  | Thomas Sandig | Lauterbach | 9,99 | gillnet |
| BRE 44 "Conny" |  | Kai Brüdgam | Breege | 10,64 | gillnet |
| FRE 31 "Binz" |  | Martin Lange | Freest | 11,95 | gillnet |
| FRE 26 "Neptun" |  | Uwe Heitmann | Freest | 13,88 | gillnet |
| WIS 121 "Marlen" |  | Martin Saager | Wismar | 17,88 | bottom trawl |
| GRO 4 "Nordstern" |  | Wolfgang Albrecht | Großenbrode | 9,33 | gillnet |
| SCHLE 26 "Filius" |  | Jörn Ross | Schleswig | 11,00 | bottom trawl |
| SH 3 "Stella Polaris" |  | John Much | Heiligenhafen | 23,97 | bottom trawl |
| BUR 11 "Marianne" | DEU300920206 | Ulrich Fröse | Burgstaaken | 14,78 | bottom trawl |
| BUR 11A "Biber" | DEU300930206 | Ulrich Fröse | Burgstaaken | 8,38 | gillnet |
| MAA1 "Ada" | DEU100210210 | Sven Detlefsen | Maasholm | 14,55 | bottom trawl |
| MAA33 "Anna" | DEU101290210 | Sven Detlefsen | Maasholm | 6,20 | gillnet |

## Results

## Number of sampled hauls per vessel

Data from BUR 6 were excluded from the following analysis, because too few hauls were sampled. This vessel stopped fishing during summertime and conducted instead tourist cruises. Furthermore, data from DRA 004 were excluded as well because the protocols were delivered too late to the OSF to include the results in the draft report.

Therefore, the following analysis is limited to data from two gillnetters: BUR 15 and GRO 7 and two trawlers: SAS 29 and SAS 110.

All data, gathered within the reference fleet in 2008 are stored in an MS ACCESS database (in total: 316 hauls). The number of sampled hauls per vessels is shown in Tab. 2.

## Catch composition

The main target species in the sampled hauls for all vessels were Baltic cod and flounder. The catch composition of the total catch from all hauls is shown in Fig. 2.


Fig. 2: Catch composition (landings and discards) per vessel of all sampled hauls
As shown in Fig. 2, the largest vessel SAS110 recorded only the target species cod, flounder and plaice. It was not possible to extend the sampling scheme for other species due to restrictions in the routine working procedures onboard. Financial incentives may be helpful to include other species in the routine sampling scheme.

## Catch per unit effort

The range of landings-per-unit-effort (LPUE) varies notable between the gillnetters and trawlers. The mean of LPUE for gillnetter is $263,7 \mathrm{~kg} /$ fishing day (total landings). All gillnetter were fishing on the same fishing ground close to the coast of eastern Fehmarn (SD 22). The trawlers SAS 29 and SAS 110 were fishing in SD 24. The size of SAS 110 is twice the size of SAS 29, which allows a duration per fishing trip of several days. This difference in size is also reflected by the difference in CPUE: 3312 $\mathrm{kg} / \mathrm{fishing}$ day (total landings) for SAS 110 and $962 \mathrm{~kg} /$ fishing day (total landings) for SAS 29.

Fig. 3 illustrates the mean LPUE (landings in kg/fishing day on monthly basis) of Baltic cod for these four vessels. SAS 110 as the largest vessel has the highest CPUE. However, this vessel was fishing in the North Sea in July and August 2008.

Tab. 4: Monthly mean catch of cod per fishing day (CPUE)

|  | BUR15 | GRO7 | SAS 29 | SAS110 |
| :--- | :---: | :---: | :---: | :---: |
| April |  |  |  | 5334,88 |
| May | 21,25 |  | 694,34 | 5265,92 |
| June | 26,17 |  | 387,85 | 2537,86 |
| July | 20,86 | 146,75 | 471,99 |  |
| August | 14,00 | 167,40 | 75,66 |  |
| September | 30,43 | 453,53 | 1002,00 | 3413,94 |
| October | 147,86 | 362,23 |  | 1336,11 |
| November | 167,71 | 191,56 |  | 1241,67 |
| December | 269,17 |  |  |  |
| fishing days | $\mathbf{8 6}$ | $\mathbf{5 1}$ | $\mathbf{1 8}$ | $\mathbf{4 8}$ |
| mean <br> CPUE | $\mathbf{8 7 , 1 8}$ | $\mathbf{2 6 4 , 2 9}$ | $\mathbf{5 2 6 , 3 7}$ | $\mathbf{3 1 8 8 , 4 0}$ |



Fig. 3: Monthly mean landings of cod of four vessels

Cod landings and discards




Fig. 4: Cod landings and discards per fishing day

For each haul the amount of cod discards (in kg ) was registered. The amount of landings and discards of cod are given in Fig. 4. The discard ratio for cod is given in Fig. 5.


Fig. 5 Discard ratio of cod (in terms of weight). The average discard rate is calculated as overall sum of discards/overall sum of landings (\%)

For gillnetters the mean discard rate of cod is lower than $1 \%$. For trawlers the mean discard rate of cod was around $7 \%$. The share of cod discards increased within the time of the year (SAS 110), whereas the overall rate of cod landings decreased.

## Comparison with observer cruises

A crucial aspect in self-sampling schemes is the reliability of the final data output. In order to check the quality of these data some sampling was conducted by observers onboard of the participating vessels. Overall, the estimated discard rates of fishermen and of scientific personnel showed no significant differences. Due to personnel restrictions, this comparative sampling could not be accomplished.

## Discussion

All participating fishermen are generally interested to continue the cooperation. But not all of them want to continue the work within the reference fleet. However, they promised to stay in close contact with the Institute of Baltic Sea Fisheries (OSF). Following reasons for the termination of the participation were given:

- changes in ownership of the vessel (1 vessel)
- the recording of information, especially discard data, requires too much effort to be conducted on voluntary basis

Four fishermen (Bur 6, DRA 004, GRO 7, BUR 15) have agreed to fill out the protocols after JOIFISH/Lot8.

Beside regular discussion (on board or via phone) a questionnaire was developed to gather standardized feedback from fishermen - "Questionnaire for the analysis and evaluation of co-operation between fishermen and scientists" (chapter 7.6/annex 2)

- Statements about JOIFISH/Lot8:

Six out of seven fishermen worked in scientific projects before JOIFISH/Lot8. All fishermen regarded the communication with the Institute of Baltic Sea Fisheries (OSF) as positive and are well informed about this project. They estimated the sense and purpose of this feasibility study as very meaningful and as „a first step in the correct direction ".

- Statements about protocols:

Four out of six fishermen need on average $20-30$ minutes per haul to gather the data (catch composition) and further 15 minutes to fill the protocols. The discard was determined by estimation by four out of six fishermen, whereby the procedure (weighing or estimating) depends on the size of the catch.

### 3.2.1.1.4 Denmark

## Establishing contacts to fishermen - selection of fishermen

At a meeting between the Bornholm Fisherman's organisation and DTU-Aqua the $16^{\text {th }}$ of October 2007 a contact was established between the fishermen and the scientist to conduct a reference fleet for vessels operating in the Baltic Sea. From the 17 participating fishermen 12 volunteered to join the reference fleet. However, information has only been received from 6 of the fisherman and with time this number has decreased to 4 .
To maintain the partnership with the fishermen in the project regular telephone contacts were established.
The $22^{\text {nd }}$ of November 2007 an article was published in the Fishermens newspaper to inform about the reference fleet and to urge more fishermen to participate. As a result, an additional fisherman was convinced to participate in the programme.

## Danish Reference Fleet - setup

For the Danish Reference Fleet five trawlers were included in the analysis (Tab. 5). It was not possible to select fishermen who were only operating in the Western Baltic Sea and all participating vessels are fishing parts of their quota for cod in the Eastern Baltic Sea, some are targeting Nephrops in Kattegat part of the year or sprat in Western Baltic and the North Sea. Data have been received for the total year all though the analysis presented in this report only deals with the cod fishery in the Baltic.

Tab. 5: Ships information from participating vessels in reference fleet

| ship | call sign/ name | captain | homeport | vessel length (m) | gear | number of hauls | total cod landings [kg] | CPUE [kg/day] (total landings /catching day) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | $\begin{gathered} \text { R194 } \\ \text { "Andrea" } \\ \text { DNK000005491 } \end{gathered}$ | Thomas <br> Fuch Thomson | Nexø | 16,02 | Bottom trawl Pelagic al trawl | 127 | 169105 | 311 |
|  | R218 „Judith Bechmann" DNK000006541 | Henrik Nordbo Bechmann Jensen | Nexø | 25,91 | Bottom trawl | 69 | 206476 | 765 |
|  | $\begin{gathered} \text { R3 } \\ \text { „Brileda" } \\ \text { DNK000007234 } \end{gathered}$ | Partrederiet Brileda | Allinge | 16,05 | Bottom trawl | 83 | 88346 | 172 |
|  | R355 „Trine Louise" DNK000013667 | Jan <br> Andersen | Nexø | 19,09 | Trawl | 77 | 210710 | 849 |
|  | FN272 <br> "Tine Malene" DNK000005531 | Gregers V. Jacobsen | Lesø | 13,9 | trawl |  |  |  |

From the participating vessels only data from the four has been included in the report as the $5^{\text {th }}$ ship "Tine Malene" came in rather late in the project and was mainly fishing in the Kattegat area.

## Danish Reference Fleet - results

## Number of sampled hauls per vessel

All data, gathered within the reference fleet in 2007 and 2008 are stored in an EXCEL database (in total: 356 hauls). The number of sampled hauls per vessels is shown in Tab. 5. From the 5 participating vessels only two are still in 2009 sending in their data.

## Catch composition

The five analysed vessel showed a different behaviour towards target species. The larger ship "Judith- Bechmann" landed nearly only cod. Plaice and flounder composed less than $0.1 \%$ of the total catch. The ship had an average CPUE of 765 $\mathrm{kg} / \mathrm{h}$ of cod. Also the 19 meter vessel "Trine -Louise" showed a much directed cod fishery, with almost no landed plaice and no landed flounders. The average CPUE for this vessel was $849 \mathrm{~kg} / \mathrm{h}$. In contrast, the smaller vessel "Brileda" landed more species. Plaice and flounder contributed to $26 \%$ and $54 \%$ respectively of the total catch. However, the average CPUE for cod were considerably lower $172 \mathrm{~kg} / \mathrm{h}$. Also for the other small vessel "Andrea" landed plaice and flounder but here they only contribute 4 and $3 \%$ of the total catch, respectively. This ship had an average CPUE for cod in between the former vessels with $311 \mathrm{~kg} / \mathrm{h}$.

## Catch per unit effort (CPUE)

CPUE (kg/h) for cod landings and discard were calculated for all four vessels during the time period. A considerably variation in CPUE were detected between vessels and seasons Fig. 7


Fig. 6: CPUE for cod landings and discard the four participating vessels


Fig. 7: Average CPUE (landings and discard) by month for "Andrea"

## Discard

In the Baltic area, the main discard in the cod fishery are considered cod, flounder and plaice. However, the details in the discard information from the reference fleet were at different detailed level between vessels. Some vessels registered very (if any) discard although the cod catches had been really high. For this reason it can be misleading to use the value as a direct discard measure. However for a few of the vessels the information seemed rather detailed and the following analysis is conducted on these ships only.

A very clear correlation was found between the total catch of cod and the weight of the discarded cod Fig. 9. This could be expected as the cod just below landing size would be expected to be caught in the same area as the above landing size cod.

In contrast, there were hardly any correlation between cod landings and the flounder or plaice discards


Fig. 8: Correlation between cod landings and discard of cod, flounder and plaice, respectively

## Discussion

It was planned to have observers onboard the participating vessels to give further instructions on how to conduct length measurements and to make comparable studies between trips with and without observers. Due to logistic problems it has not been possible to have observers onboard this vessel until now.

It was also planned to use VMS data for quality analysis of the fishermen's logbook. This information has in Denmark been available for 2006 and 2007 since May 2008 and standard analysis can be preformed. However, as the 2008 data has not been released at present time, the VMS data could not be used for verification of data.

### 3.2.1.1.5 Sweden

## Establishing contacts to fishermen - selection of fishermen

The first attempt to engage fishermen was through calling randomly selected fishermen and encouraging them to engage in the sampling programme. This did not work out successfully as nobody accepted to participate.
After this, contact with fishermen was established through the sampling programme connected with the DCR and observers working locally in the field approached the fishermen.
Information was also spread through local meetings with the fishermen's organisation. Many seemed interested but when asked to fill the sampling forms a large portion of the approached fishermen declined. The reasons varied but most common was fear of what would happen with the results and lack of staff on board to do the sampling.

## Swedish Reference Fleet - setup

The fishermen who finally accepted to perform the sampling were 3 trawlers and 5 gillnetters. Due to the structure of the Swedish fishing fleet it was hard to find fishermen who were exclusively active in SD 24. The trawlers were all from Simrishamn in SE of Sweden where it is easy to fish in both SD 24 and 25. Hence the sampling reported was mostly from SD 25.

## Swedish Reference Fleet - results

A total of 67 gillnet sets was sampled by three boats. Landings and discards of cod are shown in Fig. 9.
The total catch of Cod was 3 tonnes with 858 kg discards. Other species caught was flounder, place, garfish, common whitefish, whiting and turbot.
Overall the discards rate was very small between 0-33\%. Only in two sets were the discard over $20 \%$ (Station 52 and 53 ) this was caused by seal eating from the catch.


Fig. 9: Landings and discards of Cod in kg by Swedish reference fleet in JOIFISH/Lot8

## Discussion

The fallout of fishermen from the reference fleet was in two cases of the trawlers explained by too much work was involved filling out the forms and they had not enough staff onboard. In one case the fishing boat changed target species from cod to herring. The two gillnetters that did not fulfil the sampling changed gears from gillnet to longline.
Experiences from the reference fleet setup are that personal contact is vital to establish a trust worthy connection. Furthermore the follow up is very important and contact should be held with the fisherman as often as possible.
The major problem experienced in this project was that the setup was done without any formal agreement and hence the fishermen could more easily dismay and fail to see the benefits involved for them. The goals and objectives should be clearly defined also for the fishermen and not only for the scientific purposes. In many cases in trust building activities as this, the possibility to influence and being heard is in many cases enough reward for the participants. However it would not be useful with some kind of honorary for the involved participants.
The concept however is quite feasible and there is a lot of information to be obtained. The fishermen involved seemed to have little or no problem with the sampling protocols.

### 3.2.1.1.6 Discussion/Summary

Many fishermen were interested in improved cooperation and to participate in this "test"-reference fleet in particular (at least in Denmark and Germany). In order to test and adapt the sampling scheme, the reference fleets were limited to few vessels from different metiers.
Due to differences in fishing methods and vessel design, it was difficult to design and establish a general sampling scheme. Especially the discard determination was difficult to generalize. The scientific requirements for data collection and the implementation of sampling schemes require intensive dialogue between scientist and fisherman. In contrast to Norway, where the fishermen of the reference fleets are regularly invited to meetings (incl. training) at the institute in Bergen, training in JOIFISH/Lot8 test-reference fleets was conducted directly onboard. This procedure was very time consuming, but those visits were very helpful to establish a trust-based relationship. A combination of both strategies would be helpful.
The available time for the training of fisherman and the time to analyse the observer cruises was rather limited, due to the limitations of financial/personal funding. Regularly training of fishermen on sea is essential to assure data quality.

It has been the lesson from this reference fleet that it is hard to keep the motivation for the fishermen to participate if they do not gain any incentive out of it. Here the Norwegian reference fleet is a good example, were fishermen are paid by extra quotas or cash for the information they deliver to scientist. It has also been learned that the regular personal contact between the involved fishermen and scientist is of great importance and here specially the feedback information on how the data has been used.

A meeting with all fishermen from Denmark, Sweden and Germany, who have joined the JOIFISH/Lot8 reference fleet, was planned at the end of the project. Since the reference fleet tested in JOIFISH/Lot8 was entirely voluntary, it was difficult to organize a meeting with all fishermen. Further on an international reference fleet meeting is problematic due to linguistic problems (at least for German participants).
For future reference fleet initiatives, we recommend national meetings with all participants and international coordination meetings with national representatives and interested fisherman.

As the participation at the final workshop was rather poor, the feedback regarding the implementation of the reference fleet was gathered in direct discussions and via a questionnaire (Germany).

### 3.2.1.1.7 Outlook

Whereas the reference fleet sampling scheme was practicable in all countries. In general, the reference fleet approach needs to have a solid framework including funding, incentives for fishermen (e.g. financial compensation), training and regular meetings (see Norwegian example) to have a long-term perspective.

Due to the better dialog between the fishermen's organisation and the scientist during JOIFISH/Lot8, discussions have now started in Denmark to initiate a reference fleet on a much larger scale. DTU-Aqua was hosting a meeting the 06.02.2009 to discuss a future funding plan for a national reference fleet with the Danish fisherman organisation in Denmark.

In Germany, some fishermen left the reference fleet (for reasons, see above). Nevertheless, the Institute of Baltic Sea Fisheries (OSF) will try to continue the work on this topic. As in Denmark, the creation of incentives is the most crucial point and some effort has to be spent to ensure appropriate funding.

In the Sweden, experiences gained from the JOIFISH/Lot8 project will be useful when starting up new a discard reporting programme within the DCR in 2009. In this programme fishermen shall bring discards for the observers to shore for sampling.

### 3.2.1.2 Greenlandic length measurement protocol (GImp)

### 3.2.1.2.1 Background/Introduction

Recent methods for the assessment of commercial fish stocks are mainly based on the landing/catch statistics from commercial fisheries. For assessment purposes, it is necessary to divide landings/catches into numbers per age group. A common approach is the sampling of fish length distributions in commercial catches and the estimation of shares per age group based on age-length-relationships.
The sampling of length distribution data by scientific staff is usually restricted to a relative small number of vessels and hauls (sampling events), compared to the huge number of fishing events within the entire fishing fleet. As for the data gathered in the reference fleet (data related to the fishing activity in general and catch composition, see above), for length distributions, self-sampling by fishermen could significantly improve the quantity of information available for the assessment.

### 3.2.1.2.2 General Implementation

It was aimed to implement a common sampling scheme in Sweden, Denmark and Germany. Key points of the implementation of the self-sampling of length distributions were:
a) Target species:

The self-sampling of length distributions was restricted to cod, because:

- the aim of this implementation study was to test, whether such approach is feasible in the Baltic fisheries
- cod is the most important fish species in the Baltic Sea
- several fisheries target cod (as target species or by-catch species)
b) Frequency of sampling:

The Dutch flounder self-sampling programme (ICES 2008) ask fishermen to sample on a regular schedule (two hauls per weeks: Tuesday first haul after 2 pm at starboard and Thursday first haul after 2 pm at portside). Given the irregular (temporal) activity pattern of the commercial fleets in the Baltic Sea (compared to regular fishing trips from Monday to Friday in the Dutch flatfish fishery) the Dutch approach cannot be transferred to the Western Baltic fisheries.
Therefore, it was decided that every $10^{\text {th }}$ haul has to be sampled by fishermen (starting with the beginning of the participation in the reference fleet). Given a mean of 3 hauls per day, this would result in approx. 2 samples per week.
c) Number/volume of sampling:

It was agreed that the number of length measurements should be orientated on a fixed volume of 250 kg and/or a fixed number of 200 fish per sampled haul.
d) Equipment:

Greenlandic fisheries scientists have developed a very simply, but robust length measurement system (Greenlandic length measurement protocol - Glmp). They
have used water proof paper with boxes for meta-data and centimetre-marks (Fig. 10). The length of fishes is to be marked with pins (resulting in pinholes on the paper). After the measurement the protocol can be washed, rolled and sent to the institute for registration.
This approach was applied to the self-sampling of length distributions within JOIFISH/Lot8, whereby the design was modified and pencils were used to mark the length of fish on the paper.


Fig. 10: Greenlandic length measurement protocol
For better handling of this protocol onboard, a plastic board was developed with a 5 cm vertical piece at the end, on which the paper could be fixed (Fig. 11).
lateral view of the measuring bord


Fig. 11: Length measuring board (Glmp mounted on the plastic board) in lateral and top view
e) General instructions/sampling scheme:

A general sampling instruction for fishermen was developed (chapter 7.4/Annex 2). In the manual "Instructions for biological sampling - length measurements" it is explained how to self-sample the length distribution of cod. These instructions include following aspects:

- when to take a sample for length measurement
- how to take a representative sample of the cod catch
- how many fish to be measured
- how to record the haul information (in conjunction with the protocol of the reference fleet)
- how to handle the Glmp
- how to measure the fish
- where to submit the GImp
f) Testing the developed method on selected vessels of the reference fleet:

The implementation of self-sampling length measurements was tested by some fishermen from the reference fleet to investigate the feasibility and acceptance of this kind of method.
g) Financial aspects:

The length measurement of cod onboard of commercial vessels requires additional effort, which results in an increase of working time and in some cases longer duration of fishing trips. This may justify some compensation for fishermen.
The compensation of additional effort was not coordinated between Germany, Sweden and Denmark and should be discussed on national level to fit regional requirements.
Compensation by additional quota, as for the Norwegian Reference Fleet, was not an option within this study.

### 3.2.1.2.3 Germany

## Implementation and results

In Germany, four fishermen from different regions along the German Baltic coast (gillnets and bottom trawls; Tab. 6) tested the Glmp. All these fishermen were open minded and they were familiar with scientific demands on how to conduct length measurements. Practical introductions on how to use the Glmp were given by scientists onboard of the fishing vessels.

Tab. 6: Fishermen testing the Greenlandic length measurement paper-GImp

| Captain | Vessel | Gear |
| :---: | :---: | :---: |
| Gunnar Gerth-Hansen | BUR 6 | bottom trawl |
| Dirk Jaudzim | BUR 15 | gillnet |
| Uwe Breese | SAS 29 | bottom trawl |
| Sven Detlefsen | MAA 33 / MAA 1 | gillnet / bottom trawl |



Fig. 12: Fishermen with GImp
The basis for discussions about compensation of the additional effort was a test onboard of BUR 6 (Fig. 12). Together with the owner of the vessel, the time demand was evaluated and additional costs (for working time \& vessel) were estimated. As a result, it was agreed to pay $50 €$ for each sample with correctly conducted length measurements (Glmp). This fixed rate of $50 €$ represents the upper limit of compensation. Higher rates and increased sampling intensities would lead to overall costs, which might be too high in relation to the scientific value of the self-sampling protocols.

In total, seven hauls were sampled by fishermen using the Glmp (Tab. 7). MAA 33 (gillnetter) and SAS 29 (trawler) tested the Glmp only once. They have stated, that 50 $€$ per sample is not enough to compensate the additional effort.
BUR 6 (trawler) tested the sampling procedure for 5 hauls. The length distributions of cod for each sample are presented in Fig. 13. As stated in the instructions, every $10^{\text {th }}$ hauls was sampled. The catch of cod was very low in most hauls, resulting in sample sizes far below 200 kg or 250 species, as aimed for. Therefore, following adaptation
of the proposed sampling frequency was made in January 2008 (BUR 6 - haul 3, 4 and 5):
If the sample size for the fixed $10^{\text {th }}$ number of haul is below 100 kg , the next haul, which includes more than 100 kg cod should be sampled.

Tab. 7: Overview about self-sampling of length measurements in Germany

| vessel | date | haul | total weight <br> of cod <br> [kg] | weight <br> of measured <br> cod <br> [kg] | number <br> of measured <br> fish | mean weight <br> [kg] | gear | rectangle <br> ICES- |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| BUR6 | 10.12 .2008 | 1 | 19 | 19 | 42 | 0.45 | OTB | $37 G 1$ |
| BUR6 | 28.12 .2008 | 2 | 126.3 | 126.3 | 44 | 2.87 | OTB | $37 G 1$ |
| BUR6 | 04.01 .2009 | 3 | 157.5 | 157.5 | 138 | 1.14 | OTB | $37 G 1$ |
| BUR6 | 15.01 .2009 | 4 | 267 | 267 | 271 | 0.99 | OTB | $37 G 1$ |
| BUR6 | 24.01 .2009 | 5 | 482.04 | 204 | 238 | 0.86 | OTB | $37 G 1$ |
| MAA33 | 07.05 .2008 | 1 | 164 | 164 | 184 | 0.89 | GNS | $37 G 0$ |
| SAS29 | 17.09 .2008 | 1 | 28 | 28 | 36 | 0.78 | OTB | $38 G 3$ |



Fig. 13: Length distribution of cod, sampled on three different vessels using the Glmp

### 3.2.1.2.4 Denmark

Denmark has at present not implemented the Greenland length measurement paper. It was presented to the fishermen in the beginning of the project but due to the extra workload for the fishermen it could not be implemented without further payment. However, the method has been introduced to the Danish fishermen and the Glmp will be implemented in the future Danish reference fleet where fishermen will be paid for the samples collected onboard.

### 3.2.1.2.5 Sweden

Sweden has not implemented the Greenlandic length measurement paper. It was presented to fishermen in presentation of the project. Length measurements was however not included in the task of the reference fleet due to the fact that many fishermen dropped out of the basic programme due to the burden of weighing and reporting the discards.

### 3.2.1.2.6 Discussion/Summary

The implementation of the length-self-sampling program using the Glmp (Greenlandic length measurement protocol) was difficult. It was planned to test the concept on a few vessels in Germany, Denmark and Sweden. A successful implementation could only be achieved at one German vessel for the duration of one month. Other German vessels tested the sampling only once.

The following reasons for the non-implementation of the Glmp were given:

- The number of crew/deck hands and the size of the vessel are a crucial factor to implement the Glmp on a routine basis. If only one fisherman is fishing (gillnetter BUR 15 and MAA 33), length measurements at sea are not practicable.
- Working space on smaller vessels (BUR 15, MAA 33 and SAS 29) is limited.
- It is problematic to handle the Glmp under heavy weather conditions.
- The extension of working time (sorting of cod landings \& discards and further processing the GImp) requires significant additional effort. The compensation offered to German participants ( $50 €$ per completed length sample) was obviously not enough for fishermen

However, six of seven fishermen stated (in the evaluation questionnaire, see chapter 7.6/Annex 2) that in principle self-sampling of length distribution onboard a fishing vessel is feasible. But in addition to the normal processing of the catch onboard the sampling using the Glmp requires substantial time and effort that most of fishermen are not willing to execute, particularly when larger catches need to be processed. Therefore, the financial compensation should be adapted.
On the other hand, the higher the financial incentive, the more questionable the cost effectiveness compared to other sampling approaches.

Whereas, the Glmp was not introduced successfully on all vessels, the developed sampling scheme was practicable. But sampling schemes have to be adapted, if necessary, e.g. the adaptation of sampling frequency in cases of low cod catches.

Beside JOIFISH/Lot8, the Glmp-approach was introduced by the Institute of Baltic Sea Fisheries (OSF) to the self-sampling of cod catches by German recreational fishermen.

### 3.2.2 Investigations about cod recruitment

A fundamental problem in the current assessment of Western Baltic cod (SD 22-24) is the estimation of recruitment strength, especially of the age-groups 0 and 1. Consequently, there are uncertainties in the short-term and medium-term forecast. The fishery asked for solutions related to this problem during the " $1^{\text {st }}$ Baltic Fisheries Dialogue". Hereby a co-operation between fishery and fishery science was recommended.
Fishermen and fishery organisations often criticised the sampling strategy of scientific surveys, especially the inadequate choice of sampling time, fishing gear and sampling area (e.g. no coverage of areas shallower than 20 m ). Frequently, fishermen have reported that juvenile cod could be found very close to coastal line in waters shallower than 20 meters. In consequence fishermen proposed a change of the existing sampling strategy, which includes the opportunity to react more flexible on changes of local conditions.
However, flexible adoption of survey designs contradicts the establishment of scientific time series, which are derived from the Baltic International Trawl Survey (BITS) on a fixed sampling design.
The goal of scientific surveys is to establish long time series to identify changes in the ecosystem and to get a fishery independent index the cod stock size. Any time survey series needs standardised methods, which have to be kept stable in time and which have to be coordinated internationally. The established scientific surveys have limitations, e.g.:

- available ship time
- no haul positions in shallow waters


### 3.2.2.1 Cod recruitment survey

### 3.2.2.1.1 Introduction

To tackle the problems, mentioned above, it was agreed to establish a joint "Cod Recruitment Survey (CRS)" between fishermen and fishery science by using commercial fishing vessels.

### 3.2.2.1.2 General Implementation

The CRS was characterized by:
a) The skippers of the fishing vessels have selected sampling stations prior to the survey. During this process the experience of the fishermen was of great importance. This way of selection could be used for later initiated surveys as well. The aim of the survey was to evaluate and check the possibility whether it is possible to get a better information about the year class strength of Western Baltic cod by initiating a survey with fisherman on commercial fishing vessels. On a long-term basis such data should be used as additional index within the assessment of the Western Baltic cod stock.
b) The fishing gear, which should suitable to catch cod recruits was selected and delivered by the participating fishermen.
c) The investigation period was coordinated together with the fishermen. Again the experience of fishermen regarding the occurrences of cod recruits during the year was of great importance.
d) The catches were analysed on board by scientific staff. Planning and data evaluation were done in cooperation with participating fishermen. They were also informed about the results via cruise reports. Further optimisations of the survey were discussed.
e) Whereas the fishermen chose the optimal season and the locations of the hauls, the sampling followed scientific standards (e.g. 30min per haul, measurement of hydrographical parameters after each haul, etc.)
f) No fish was landed from the CRS. The fishermen were paid by a charter fee.

To ensure an optimal sampling of small cod, the fishery stated, that such CRS should be conducted in spring and autumn if possible. Hence the $1^{\text {st }}$ CRS was carried out in April 2008, whereas only two German vessels participated.

In accordance with the experiences gathered during the $1^{\text {st }}$ (German) CRS in spring 2008, the following points were considered for the $2^{\text {nd }}$ CRS in autumn:

- international coordination (time, participating fishermen, sampling stations, fishing gear)
- sampling in shallow waters of $>10 \mathrm{~m}$ water depth
- the German survey should be conducted with the same fishing vessels as in spring

The autumn survey was planned to be conducted in Denmark, Sweden and Germany. Finally Denmark did not participated due to logistical reasons (missing man power).

The survey was scheduled for November 2008 in order to have the possibility to compare the results of the national CRS with the results derived from the Baltic International Trawl Survey Q4, which is conducted in the same month.

Cruise reports can be found in chapter 9 (Annex 4)

### 3.2.2.1.3 Germany

## Implementation

Two commercial fishing vessels were chartered to conduct this joint cod recruitment survey in Germany (Tab. 8). Both vessels were part of the German Reference Fleet (see chapter 3.2.1.1).
It was planned to use both vessels for the spring, as well for the autumn survey. Due to very bad weather condition in November 2008, the survey was conducted solely by SAS29.
The charter fee for SAS29 was 1000,- $€$ per day in April and 1190,- $€$ in November (due to higher fuel prices). The charter fee for BUR6 was already 1190,- € in April. The fee included:

- fishing vessel incl. crew
- fuel
- fishing gear, incl. potential damages and repairs
- VAT

In addition to trawl samples, hydrographical measurements were taken at each fishing station using a CTD probe (CTP 004 sensor from Sea and Sun Technologies).

A detailed description of the cruises can be found as cruise reports in chapter 9 (Annex 4). Short summaries are given below.

Tab. 8: German cod recruitment survey: Participating fishing vessels

|  | SAS 29 "Petra B." | BUR 6 "Tümmler" |
| :---: | :---: | :---: |
| Technical data |  |  |
| Year of construction | 1999 | 1983 |
| Type | Stern trawler | Stern trawler |
| Homeport | Sassnitz (Island of Rügen) | Burgstaaken (Island of Fehmarn) |
| Length over all | 11.83 m | 14.80 m |
| Draught | 2.50 m | 2.20 m |
| GRT | 1500 | 2200 |
| Material | GRP | Wood |
| Machine capacity | 133 kw (179 hp) | 176 kw (238 hp) |
| Crew | 2 | 2 |
| Gear | Custom-made eel trawl with 40 mm mesh opening in the wing and 25 mm mesh opening in the cod end | Danish eel trawl with 40 mm mesh opening in the wing and 25 mm mesh opening in the cod end |

## $1^{\text {st }}$ CRS in April 2008

The survey was carried in two areas (Fehmarn and Rügen) with two different vessels (SAS 29 and BUR 6).
During the $1^{\text {st }}$ CRS (part 1) with SAS29 samples were taken at four locations around Rügen. (Fig. 14). In total, 19 hauls were conducted. After 18 of 19 fishing station, hydrographical measurements were carried out.
During the 1st CRS (part 2) with BUR6 25 fishing stations were sampled. (Fig. 15). Due to technical problems, hydrographical measurements were carried out only on 18 of 25 stations.


Fig. 14: Scheme of sampling stations (1.Lehmberge, 2.east of Rügen, 3.Tromper Wiek, 4. Sassnitzer Graben


Fig. 15: Scheme of sampling stations around the island of Fehmarn

## $2^{\text {nd }}$ CRS in November 2008

The 2nd CRS in November 2008 was conducted only with the fishing vessel SAS 29. Bad weather conditions in November 2008 restricted the sampling to 4 days in the period from $4^{\text {th }}$ to $30^{\text {th }}$ November 2008
During this survey the same gear and nearly the same sampling area was used as in April. 18 hauls were conducted (Fig. 16). Due to technical problems, no hydrographical measurements were done.


Fig. 16: Scheme of sampling stations (1.Lehmberge, 2.Tromper, Wiek, 3. and 4. Sassnitzer Graben).

It was planned to determine the age of small cod by otolith analysis (i.e. separate 0 group and 1-group). Due to unexpected/unusual ring patterns in almost all otoliths of small cod in autumn 2008, this approach was not feasible. For more information and example of those otoliths, please refer to chapter 11 (annex 6).

## Results

Fishery
The catch per species during the German part of cod recruitment survey in 2008 is given in Fig. 17.


Fig. 17: Total catch of both surveys


Fig. 18: Catch composition within all German samples in 2008. Fraction of cod ( $<1 \%$ ) is related to the total catch of all species.

Cod recruits
In April 2008 the area around Fehmarn and the area around Rügen have shown significant different abundances of small cod. Whereas only four cod $<20 \mathrm{~cm}$ were caught around Fehmarn, 717 cod recruits $<20 \mathrm{~cm}$ were caught around Rügen In November 2008 around Rügen in total 548 cod recruits $<20 \mathrm{~cm}$ were caught. The spatial distribution of cod recruits caught during German cod recruitment surveys is shown in Fig. 20.


Fig. 19: Fraction of cod recruits of total cod catch

### 3.2.2.1.4 Comparison with the results from the International Bottom Trawl Survey with FFS "Solea" (BITS)

Catch per unit effort of the CRS data was compared with the scientific BITS (Baltic International Trawl Survey) - data from cruises of FRV "Solea" from the years 2005 till 2008 ( $1^{\text {st }}$ and $4^{\text {th }}$ quarter in each case). The geographical distribution of the sampling stations and the number of caught cod recruits $<20 \mathrm{~cm}$ (standardised on 30 minutes hauls) are illustrated in Fig. 20.

BITS data from 2005-2008 show the existence of temporal and spatial variation of the abundance of Western Baltic cod recruits.
Especially during BITS in spring 2008 fewer cod recruits were found in ICES SD 22 compared to other years. These findings were proven by the CRS conducted with BUR 6 "Tümmler".

Similar spatial patterns were found in both surveys in April. The BITS, as well as the CRS did not found any significant numbers of small cod in ICES SD22 (around Fehmarn), but found relatively large numbers in SD 24 (around Rügen).

Nevertheless, the direct comparison between scientific BITS and CRS is not possible, since the CPUE depends on several parameters, which differ between vessels and surveys. For instance, two different trawls were used during CRS and BITS:

- CRS: Eel trawl (wing 40 mm mesh opening, cod end 25 mm mesh opening)
- BITS: TV3-520 young fish trawl (lower wing 60 mm length of mesh size, 1st continuous ring 40 mm length of mesh size, cod end 10 mm length of mesh size)

However, the (long-term) aim of the CRS was to test whether it is possible to establish an index (to be used in a longer time series) for the abundance of 0-group cod in the western Baltic. Therefore, a meaningful comparison would include a comparison of the performance of a recruitment index derived from both approaches. Additionally, as said above, the poor recruitment estimate of recent surveys was the key to test other approaches. Therefore, a comparison with this "poor" index would be meaningless. Moreover, the performance of a new index would have to be evaluated in the assessment. It is not possible to follow both approaches, since no time series is available for the CRS.


Fig. 20: Catch per Unit Effort ( 30 min ) of cod $<20 \mathrm{~cm}$ from Baltic International Trawl Survey (BITS) and Cod recruitment Survey (CRS). The year and season is given in every plot. Left column: BITS $1^{\text {st }}$ quarter and CRS April 2008; Right column: BITS $4^{\text {th }}$ quarter and CRS November 2008

For more detailed information refer to the German cruise reports in chapter 9 (Annex 4)

## Cooperation between fishery and fishery science

The owner of both commercial vessels, Uwe Breese and Gunnar Gerth-Hansen, have extensive experiences with scientific projects (different scientific surveys, wind park and Gazprom studies) and were very open-minded for scientific problems. Cooperation in planning and realisation of the surveys was done without any problems. Both commercial crews were extremely communicative and flexible in work times.
Topics like safe trawling lines, further possibilities of data acquisition and trawling equipment were discussed and have to be considered in subsequent projects.

### 3.2.2.1.5 Sweden

The arrangements of the Swedish Cod Recruitment survey were rather straight forward. It was no problem finding a boat that was interested in the setup of the survey. This was perhaps due to high interest of fishermen concerning cod recruits. For this reason it was also easy to reach agreements on financial aspects.
The vessel chartered was chosen on the background of its operating area and skill of the skipper.
Time allotted for the survey was rather short. It was desirable to do the survey in connection with the Argos BITS survey in November but weather conditions and other obligations for the fishing vessel made the time frame limited in which we could perform the survey. As a feasibility study it was however very successful and this way to co-operate was very useful for both scientists and fishermen.
Co-ordination between Germany and Sweden was very helpful and the fact that two surveys were conducted in April 2008 helped the outline for the Swedish survey in November.

For results of the Swedish CRS see chapter 9.4 (Annex 4).

### 3.2.2.1.6 Discussion/Summary

Based on the rather poor estimates of the year-class strength of Western Baltic cod estimated from scientific surveys, the fishery recommended to conduct a joint cod recruitment survey (CRS). The fishermen argued that the present scientific estimates of the year-class strength are biased due to following reasons:
a) sampling during the wrong season
b) using the wrong fishing gear
c) selection of wrong stations (i.e. no coverage of shallower areas)
d) no consideration of fishermen's practical experience.

Therefore, participating fishermen were responsible for the selection of the time period, the fishing gear and stations.

Re a) The cod recruitment surveys were conducted in the same season as the Baltic International Trawl Survey (BITS) in Q1 and Q4. Therefore, argument a) seemed to be not relevant.

Re b) Participating fishermen have agreed to use eel-trawls, since it seems that they are optimal to catch small cod and most fishermen in the Western Baltic are presently using those nets. Although the catch per unit effort (CPUE) between BITS and CRS was compared, it is difficult to determine which gear is more suitable for this task without direct comparison. Additionally, it is not necessary to get the best CPUE, since for assessment purposes only indices (relative estimates) are needed.

Rec) As the charter fee included the usage of the gear and no compensation was paid in cases of net damages, the selection of the stations by fishermen was safetydriven. In shallow areas, the number of "clean" trawl positions is rather limited, resulting in high risk for the gear and the vessel. This resulted in a low coverage of shallow water areas. A few stations near Rügen were conducted in shallow waters, but they were finally cancelled after considerable net damages.

Re d) The experience of fishermen was taken into consideration.
Consequently, at least two out of four (potential) problems of scientific surveys were not solved by this type of survey design. Therefore, the results from a cod recruitment survey with commercial vessel (under the present setup) would not enhance the quality of the present data situation.

Even if the surveys would have been successful, following further problems are restricting the use of commercial vessels for the establishment of a longer time series needed for the assessment:

- Financial restrictions:
- only vessels smaller than 15 m were chartered
- the number of days at sea was limited
- the funding in upcoming years is unclear
- Restriction to the selection of small vessels:
- no possibility to fish at windy conditions (4 Bft or more)
- one-day trips and hence the area of investigations is restricted to fishing stations near the home port
- restricted possibilities/space of work facilities onboard

Some additional effort was spent at the Institute of Baltic Sea Fisheries in Rostock (Germany) to investigate the possibility to expand the BITS into shallower areas. In addition to the charter of commercial vessels, the feasibility of a BITSSW (BITS shallow water) was tested with the research vessel "Clupea" (17.6m). During this BITSSW ( $1^{\text {st }}$ quarter and $4^{\text {th }}$ quarter), similar problems as stated above for small vessels were encountered. Therefore, this kind of exercise will not be repeated until the new research vessel RV"Clupea" is available (planned for 2010).

Although the cooperation with participating fishermen was excellent, the continuation of the CRS in its present form cannot be recommended for the reasons described above.

In this context several fishermen suggested the sampling of cod recruits in the pound-net fishery as an alternative approach. Therefore, a self-sampling scheme for this kind of fishery was developed in cooperation with fishermen. The sampling started in autumn 2008. For more detailed information see chapter 3.2.2.2.

### 3.2.2.2 Pound net fishery

### 3.2.2.2.1 Background/Introduction

As mentioned above (chapter 2.2.2), the assessment of Western Baltic cod is hampered by uncertain estimates of the recruitment strength.

As consequence, fishery and fishery science have agreed (during the 1st Baltic Fisheries Dialogue Meeting) to solve this problem together. The primary approach was to test the feasibility of a joint cod recruitment survey (CRS) - a survey conducted with commercial fishing vessels (trawler). For more information on this approach, please refer to chapter 3.2.2.1. However, analysing the survey data revealed some limitations in the setup of a young cod survey e.g. area distribution and trawlers are not able to sample in very shallow water.
An alternative way to sample cod recruits was developed within JOIFISH/Lot8 and one of the main tasks was to cover the depth intervals where young cod were expected to be found. As follow up of the poor catches of small cod in the area around Fehmarn during the 1st CRS, an intensive discussion between fishermen and scientist started. Some of the fishermen suggested, that the sampled water depth is the main problem. The average water depth which was sampled during that cruise was 23.0 m . But in their opinion cod recruits prefer habitats with water depth from 3.0 to 15.0 meters, whereby the time and gear of sampling have to be adjusted:

- The best time to catch 0-group cod is from September to November.
- Appropriate gears to target 0-group cod in shallow waters are pound nets (Fig. 21). In these nets high numbers of small cod are caught as bycatch, whereas a high survival rate is assumed.

The number of fishermen who practise this fishing method is relatively low (at least along the German coast).


Fig. 21: Pound net - fish trap construction

### 3.2.2.2.2 General Implementation

German fishermen from Fehmarn Island and Danish fishermen from Funen and Lolland have expressed their interest to work in this "sub"-project.

Common protocols and a common sampling strategy were developed in close cooperation between fishermen and scientists. See chapter 7.5 (Annex 2) for an example of the protocol.

The number of cod recruits in every catch was counted or estimated by fishermen. This sampling took place during usual commercial fishing activity and was a kind of self-sampling. The sampling was conducted from September to December in 2008. However, sampling periods differed between sites (Fig. 22, Tab. 9, Tab. 10). The pound nets were controlled depending on the weather conditions every 24 to 96 hours.
Additionally, fishermen were asked to deliver one frozen sample of small cod per week. Thereby the whole catch from one haul or a subsample with a weight of approx. 1 kg was frozen. Length and weight of cod recruits were measured at the OSF laboratory by technical assistants. Both otoliths were extracted and archived for further analysis.

Please, refer to chapter 11 (annex 6) for a detailed analysis of this subproject.


Fig. 22: Sample sites of cod recruits in pound net fishery. Sites I-III were located at northwestern coast of Funen Island, next to the Little Belt. Sites IV-VI were located at the southwestern coast of Lolland. Sites from Fehmarn (VII-XIII) are grouped in sites at northern Fehmarn (sites VII-X), southeastern Fehmarn (site XI) and southern Fehmarn (sites XII-XIII). For geographical positions, please refer to Tab. 9. (source: Google Inc.)

Tab. 9: Position and depth of the fishing sites grouped by location

| site | location | position | depth | sampling period |
| :---: | :---: | :---: | :---: | :---: |
| I |  | $55^{\circ} 25^{\prime}$ N, $9^{\circ} 46{ }^{\prime} \mathrm{E}$ | 2m | 13.Oct. - 10.Nov. |
| II | Funen | $55^{\circ} 27{ }^{\prime}$ N, $9^{\circ} 43^{\prime} \mathrm{E}$ | 3 m | 13.Oct. - 10.Nov. |
| III |  | $55^{\circ} 29^{\prime} \mathrm{N}, 9^{\circ} 43^{\prime} \mathrm{E}$ | 4 m | 13.Oct. - 11.Nov. |
| IV |  | $54^{\circ} 41.03^{\prime} \mathrm{N}, 11^{\circ} 17.69^{\prime} \mathrm{E}$ | 4.5 m | 05.Oct. - 17.Nov. |
| V | Lolland | $54^{\circ} 41.26{ }^{\prime} \mathrm{N}, 11^{\circ} 16.72^{\prime} \mathrm{E}$ | 6 m | 05.Oct. - 22.Nov. |
| VI |  | $54^{\circ} 42.03^{\prime} \mathrm{N}, 11^{\circ} 13.76{ }^{\prime} \mathrm{E}$ | 6.5 m | 05.Oct. - 22.Nov. |
| VII |  | $54^{\circ} 31.502^{\prime} \mathrm{N}, 11^{\circ} 08.780^{\prime} \mathrm{E}$ | 4 m | 18.Sept. - 28.Nov. |
| VIII | northern Fehmarn | $54^{\circ} 31.850^{\prime} \mathrm{N}, 11^{\circ} 06.284^{\prime} \mathrm{E}$ | 4 m | 29.Sept. - 12.Nov. |
| IX | northern Fehmarn | $54^{\circ} 30.160^{\prime} \mathrm{N}, 11^{\circ} 14.134^{\prime} \mathrm{E}$ | 4 m | 19.Sept. - 28.Nov. |
| $X$ |  | $54^{\circ} 24.600^{\prime} \mathrm{N}, 11^{\circ} 13.170^{\prime} \mathrm{E}$ | 3.5 m | 28.Sept. - 11.Dec. |
| XI | southeastern Fehmarn | $54^{\circ} 24.441^{\prime} \mathrm{N}, 11^{\circ} 16.018^{\prime} \mathrm{E}$ | 4 m | 11.Sept. -11.Dec. |
| XII | southern Fehmarn | $54^{\circ} 22.139^{\prime} \mathrm{N}, 11^{\circ} 07.421^{\prime} \mathrm{E}$ | 3 m | 11.Sept. - 23.Nov. |
| XIII |  | $54^{\circ} 21.786^{\prime} \mathrm{N}, 11^{\circ} 06.592{ }^{\prime} \mathrm{E}$ | 4 m | 11.Sept. - 05.Dec. |

Tab. 10: Sampling periods and catch durations for each sites. Periods are colored, catch durations are given in hours at heaving days. Dates of laboratory sampling are illustrated in the outermost column. Question marks indicate samplings with unknown


### 3.2.2.2.3 Germany

## Implementation

With the support of the fishery organisation from Fehmarn it was possible to find two German pound net fishermen who were willing to participate in the study. Both were selected for the following reasons:

- due to their experiences regarding the occurrences of cod recruits in the past years
- regarding their large pound nets on different places all around Fehmarn
- they check their nets nearly every day (depending on weather conditions)
- they were willing to work during this feasibility study for a small allowance only
- they were very interested about the project and its continuation

The two vessels have participated:

- BUR 11A "Biber" with homeport in Burg at the island of Fehmarn owned by U.Fröse
- BUR 9 "Anna" with homeport in Burg at the island of Fehmarn owned by E.Pahlke


## Configuration of the pound nets

All sampled German pound nets were situated really close to the shore (Fig. 23). The leader nets were positioned at a right angle to the shore. They started at a water depth of 0.5 m and ended at a depth of 5 to 7 m . Leaders were approx. 200 m in length. The leader net guides fishes to the wing and afterwards toward the enclosure core of the net. The dimension of this last section of the pound net is circa $6 \times 12 \mathrm{~m}$.


Fig. 23: German pound net located around the island of Fehmarn

### 3.2.2.2.4 Denmark

## Implementation

The idea of sampling young cod in pound nets was initiated by the fishermen and industry. Two meetings were arranged between scientist from DTU-Aqua and by the fishermen's organisation. In Denmark the fishermen's organisation is subdivided in 4 districts; North, East, South and Northeast. The chairs of the two districts South Allan Buch and East, Kim K. Hansen were very interested in cooperation and the meetings were arranged within each of there districts. The $15^{\text {th }}$ of September 2008 a meeting was conducted in Middelfart with the chair of the district South and two pound net fishermen. The $29^{\text {th }}$ of September a meeting was conducted in Klintholm with 6 pound net fishermen willing to participate and with the chair of the district east. At both meetings fishermen informed that the amount of young cod in there pound nets in 2008 were the largest level seen in a decade. This information seems to be consistent from all areas and also information from pound net fishermen in Kattegat confirm this good 2008 year class. However, only logbook and fish samples from 2 fishermen have been received at present time, one from each of the districts.

Each of the fishermen where asked to choose three nets representing different depths and to cover as large an area as possible. Freezers were bought and placed in harbours were the fishermen normally landed there eels. Scientific personal collected the samples when the freezers were full. Logbook information was sent with a pre fabricated convolute to the institute.

The two participating vessels:

- VE 212 "Ellen" with homeport at the island of Funen owned by K.Hansen
- FN 194 "Stina" with homeport in Rødby at the island of Falster owned by J.Rassmussen

The Danish pound nets were situated close to the shore, with the Western pound nets placed shallower than the Southern pound nets Fig. 24. The leader nets were positioned at a right angle to the shore. The eastern pound nets were situated from $4-6.5$ meters and with a 22 mm mesh size in the inner net. The southern pound nets were placed from 2-4 meters with an 18 mm mesh size in the inner net.


Fig. 24: More detailed information on the distribution of the Danish pound net locations

### 3.2.2.2.5 Sweden

Eel fishery in Sweden is currently only performed on exemption and the pound net fishery was excluded from the Swedish part of the programme.

### 3.2.2.2.6 Results (Denmark+Germany)

A total of 12007 juvenile cod ( $<20 \mathrm{~cm}$ ) were caught at Funen, 16355 at Lolland and 10660 at Fehmarn (Tab. 11), whereas Danish samples provided fewer number of sites and shorter sampling periods, higher numbers of juvenile cod (< 20 cm ) were caught compared to Fehmarn.

Tab. 11: Catches of cod at different size classes and sample sites over the entire sampling period

| site | location | depth | $<20 \mathrm{~cm}$ (number) | 20-38cm (number) | $>38 \mathrm{~cm}[\mathrm{~kg}]$ |
| :---: | :---: | :---: | ---: | ---: | ---: |
| I |  | 2 m | 2711 | 386 | 15.5 |
| II | Funen | 3 m | 6578 | 760 | 22.38 |
| III |  | 4 m | 2718 | 405 | 5 |
|  | Total |  | 12007 | 1551 | 42.88 |
|  |  | 4.5 m | 3205 | 600 | 20 |
| IV | Lolland | 6 m | 8625 | 1672 | 50 |
| V |  | 6.5 m | 4525 | 2002 | 53 |
| VI | Total |  | 16355 | 4274 | 123 |
|  |  | 4 m | 2390 |  |  |
|  |  | 4 m | 2680 | 702 | 156 |
| VII |  | 820 | 590 | 100 |  |
| VIII | Northern Fehmarn | 4 m | 866 | 393 | 160 |
| IX |  | 3.5 m | 1415 | 436 | 339 |
| X |  | 990 | 360 | 139 |  |
| XI | southeastern Fehmarn | 4 m | 1499 | 208 | 50 |
| XII | southern Fehmarn | 3 m | 4 m | 10660 | 400 |
| XIII | Sotal |  |  | 3089 | 154 |
|  |  |  |  |  |  |

For detailed information about catch and growth of juvenile cod and analysis regarding abiotic factors (meteorology and hydrography) see chapter 11 (Annex 6)


Fig. 25: Temporal development of catch per unit effort (24h), shown for every sampling site. Plots from different areas are organized in rows. From top: Funen, Lolland, northern Fehmarn, southeastern Fehmarn, southern Fehmarn. First catches from Lolland exceed the limit of the $y$ axis. These values are added manually.

### 3.2.2.2.7 Discussion/Summary

The sampling of small cod using pound nets was very successful. The participating fishermen were interested to get involved into this kind of scientific research. They were very helpful and gave a lot of information on the distribution of cod recruits in the past years (unfortunately not quantitative) and they are interested in a further cooperation.
Certainly, there must be an adequate financial compensation in the future because:

- the effort for counting the cod recruits is very time consuming
- a better incentive would increase the probability that sampling would be conducted over longer time periods (more years) including more participants
- a better incentive would lead most likely to an increase of the quality of data


## Recommendation

The present design has following advantages:

- the pound net fishery is suitable for long time series, due to the fact that the pound nets are fixed at the same place for years
- pound nets could be easily equipped with different types of data logger
- minimum of scientific man power needed for supervision and analysis
- cost-effective way to get data of cod recruits and hydrographical data
- the extension to other areas in the Baltic may be possible
- the involvement of the fishermen in the data collection programme

However, the sampling design needs following revisions:

- protocols must be filled in uniformly
- uniform sampling periods (i.e. duration of fishing season) would be helpful to compare the catches of different areas
- the reduction of catch durations would be helpful to avoid saturation effects
- diet analyzes are necessary to study the impact of cannibalism on catches of small cod (one possible reason for saturation effects)
- the number of small cod per laboratory sample have to be increased to ensure a sufficient length distribution
- the size range of predefined size groups has to be adapted, since the analysis of growth has shown, that a significant proportion of 0-group cod is larger than 20 cm in November/December.
- the separation of 0-group and (small individuals) age 1 cod within the new proposed size group $<25 \mathrm{~cm}$ has to be done by using otolith age readings.


### 3.2.3 Poland's Discard Project

"Determining the magnitude of discards in the Baltic cod catches and further actions with regard to them if no-discard fisheries is implemented"

The main goal of the project was to determine the magnitude of discards in Polish cod fisheries by strengthening the co-operation between fisheries scientists and fishing sector. Joint data collection was expected to provide data of good quality on real levels of by-catches and discards which will also be used for recognizing problems associated with landings of the whole catch (landings and discards) in case of no-discard fisheries implementation (COM(2007) 136 final). The Polish part of the EU -project JOIFISH/Lot8 had begun in January 2008 and was delayed by 6 months as compared to initial plan due to the cod ban on Polish fisheries for the second half of 2007. Data collection was finalized on 30 of June 2008 due to temporal termination of Polish cod catches implemented by Ministry of Agriculture and Rural Development

For the purpose of the project four fishing vessels were randomly selected from the list of vessels grouped according to vessel type (trawlers and gillnetters) and also representing eastern (ICES Sub-division 26) and western (ICES Sub-division 25) waters of Polish coast (taking into account location of home-ports
Finally, two gillnetters ( 18 m and 17.5 m length) and two trawlers -14.8 m length (fishing with BACOMA cod end) and 22 m length fishing with turned meshes in cod end -T90). One trawler and one gillnetter were exploiting fishing grounds in eastern part of the Polish EEZ and another trawler and gillnetter were operating in western part
It was intended to cover fishing trips with an observer on board (either scientist or fish inspector) to the highest possible degree. The role of the observer was to record the weight of the catch divided by species, separately for landed and discarded part of the catch. It was also observer duty to measure fish species. In case of no-observer trips no length measurements were made but registering the weight of species was the responsibility of the skippers who were prepared for that role by the Institute staff.

For detailed information and the whole project report see chapter 10 (Annex 5)

### 3.3 Task 3: Implementation of programmes into assessment

Responsible partner: DTU-Aqua (Denmark)

"The final goal of the data sampling is to improve stock assessment procedures and scientific advices. Therefore, parallel to the in situ implementation, work should be undertaken to integrate the sampled data into up-to date assessment procedures. As the data has not yet been collected at this stage, the work will be done on already existing data from scientific surveys or on simulated data. Examples: if it is decided to improve discard sampling, the implementation into the assessment procedures is fairly straightforward, as this will be used to adjust the total catch at age and potentially CPUE data series used for tuning purposes. In the case of an ichthyoplankton survey, more development on procedures to turn measured densities of eggs and larvae into estimates on spawning stock biomass has to be performed, but previous experience exists already for cod and sprat." (from application)

As the data do not have a time series long enough to implement it in the assessment, test runs will be preformed on already existing data from scientific surveys or logbook data. Furthermore some guidelines for the input data to be used in assessment will be stated.

- If discard sampling is improved, due to a self-sampling program the implementation into the assessment procedures is fairly straightforward, as this will be used to adjust the total catch at age and potentially CPUE data series used for tuning purposes.
- In the case of a new recruitment index (survey or pound net), a direct input in the short-term forecast is possible when the time series has a duration of at least 5 years. It would be possible to use this index in addition to the already existing young cod index from "Solea" and "Havfisken" or as a separate index.
- A new commercial tuning fleet has been founded to analyse if commercial data could improve the assessment when some of the problems with commercial tuning fleets were accounted for. E.g. only using a sub-sample of the fleet, only using vessels with a home port in the reference area and standardize the vessels to kW-days we can not account for other technical improvements due to lack of knowledge on this topic.

Prior to the benchmark assessment for the Western Baltic cod stock in January 2009 (ICES 2009) a new commercial tuning series was implemented and sensitivity analysis conducted to improve the assessment.

This exercise is used to investigate the usage of a new commercial tuning series in the assessment of the Western Baltic cod.

### 3.3.1 A commercial tuning fleet

### 3.3.1.1 Data selection for tuning fleets

A new commercial tuning series was founded to improve the input data quality for the assessment of the Western Baltic cod stock. In the last year's assessment the tuning series in the assessment has consisted of 3 scientific and 2 commercial fleets. The scientific surveys have been conducted with the German vessel "Solea" and the Danish scientific vessel "Havfisken". The commercial tuning fleets have been the Danish trawlers>105 mm mesh size and Danish gillnetters $120-160 \mathrm{~mm}$ mesh size. However due to the common age-length key applied from the total Danish port sampling program, a bias in the correlation between the commercial tuning fleets were applied. Therefore a new approach was introduced with a much smaller subsample of the fleet and with an age-length key specific from the area used for the reference fleet (Bastardie 2009).

The selection procedure was based on the following criteria: (i) to subset the codspecialist activity i.e. all activities exclusively directed to cod catches in order to get an unbiased CPUE time series based on the effort targeting cod (otherwise, possible under-estimation of the cod CPUE in case of effort directed toward other species); (ii) to subset all activities acting with a given and unique fishing gear combination because first the variance in catch rates per species is mainly impacted by the gear used, and second the use of the similar combination of gears is likely to reflect a homogeneous fishing behaviour pattern; (iii) to subset all activities exclusively included in area delimitation of the stock reflecting similar fishing behaviour pattern; (iv) to remove all activities subject to misreported landings and discarding for which effort and catch data are not reliable. Using these criteria, we expect to get the most homogeneous subset of activities (especially in terms of fishing behaviour pattern) relevant for tuning the Western Baltic cod assessment. The available data to run the subset is the trip-based Danish DFAD database merging logbook information with sales slip. The database lists the catches trip by trip for each vessel and by ICES squares. The point (iv) has not been undertaken due to lack of data on the misreporting aspect. The same arrangement is run for each year over the desired year range of the tuning fleets. Note that, processing by year, a fleet may not be constituted by the same vessels over the years. The total cod landings of each trip were then converted to landings per age using an allocation key from the data analysis. The decomposition of landings in age group is deduced from harbour sampling of fish length and fish ageing from otolith reading after building an agelength key.

CPUE standardisation
Inside each selected fleet, a standardisation procedure is applied to extract the year effect on which index of abundance can be based using a Generalized Linear Models (GLMs) with log-link. The minimal efficient model found in the model selection was for the trawler fleet was:
CPUE = year + kW + year:age

The time series cover the period 1987 - present, whereas only data from 1992 to the present were used. The CPUE information for the commercial fisheries was extracted from the Danish log-book database. This database provides information by vessel size, kWatt, fishing gear and mesh-size, effort measured as days at sea and catches separated into five market categories (i.e., size groups) on a trip-by-trip basis. The age composition in the catches is derived by linking the landings in each market category with information on age composition by market category (a market category-age key). CPUE were standardised to fleets by the ANOVA $\ln (C P U E)=$ Year*month + Vessel size + kW. The estimated vessel size effect were retransformed and used to correct the fishing power of different vessel sizes to a common size standard. The input data is presented as catch in numbers in age groups 1 to 6 and standardised effort unit by fleet. Selectivity in age 1 and 2 in this fleet is believed to have changed after the introduction of the BACOMA window.

### 3.3.1.2 Quality and sensitivity analysis of data

Quality analyses were preformed on the new commercial tuning fleet to test if there were a reasonable internal consistency. Furthermore a sensitivity analysis were preformed to look at the changes in assessment when the new an improved data series were introduced.
The internal consistency plot of the new commercial tuning fleets showed a reasonable consistency plot for the trawlers but a rather poor consistency in the gillnetter fleet. Consistency analyses were conducted to test how good a year class could be followed between years and from this it was concluded that the gillnetters did not show a very good internal consistency and was therefore excluded for further analysis. The consistency analysis of the new commercial trawlers showed however a fine internal consistency and was included in the final assessment (Fig. 26)


Fig. 26: Internal consistency plot from the new tuning series with commercial trawlers (left) and gillnetters (right).

Danish commercial tuning fleet:
The new commercial tuning fleets were plotted against the former tuning fleet to observe if year-classes changed between the series. From these test it was shown that for nearly all year-classes same pattern were evident in the new tuning series and in the former. However, some differences were seen at age 6 between the series for both the trawlers and gillnetters.


Fig. 27: Left: Former Danish trawler tuning fleet in blue and new Danish specialist trawler fleet in pink by age groups and years; Right: .Former Danish gillnetter tuning fleet in blue and new Danish gillnetter fleet in pink by age groups and years

Sensitivity analysis were preformed on the different new commercial tuning fleets and compared to the assessment conducted in 2008 (ICES 2008b). The results showed that with a large shrinked as has been used in the assessment in 2008 the influence of the changed tuning fleet is of no importance for recruitment and SSB but fishing mortality is increased a bit implementing the new commercial fleets.


Fig. 28: Comparison between different tuning fleet runs with the settings used in the 2008 assessment.

### 3.3.1.3 Conclusions on use of commercial tuning fleets in assessment

Commercial tuning fleets have for a longer time period been considered inappropriate to use in an analytic assessment due to the correlation between the catch matrix and the commercial tuning fleet. Another problem is the technical creeping in the commercial fleet, which can bee very difficult to account for. However, if the surveys are not catching older year-classes, these year-classes are not proper represented in the assessment. Although, we have tried to account for some of the problems with a commercial tuning fleet in this study, e.g. only using a sub-sample of the fleet, only using vessels with a home port in the reference area and standardize the vessels to kW-days we cannot account for other technical improvement due to lack of knowledge on this area. This information will however be available in a reference fleet. Here it would be possible to get haul-by-haul information increasing the quality of the effort data, to have information on different technical improvements and as the reference fleet will consists of the same subset of vessels it will ease the task of withdrawing the catch data from the catch- matrix. The age length key will also be much improved for a reference fleet were otoliths will be sampled from the fleet represented in the reference fleet and not from a common age-length key from harbour samples. The conclusion from this study is that although there are problems with introducing a commercial tuning fleet, the information from this segments is of large importance for the assessment and that a reference fleet could overcome the problems with technical creeping and correlation between catch matrix and tuning fleet.

### 3.3.2 Recruitment index for Western Baltic Cod

Herewith, we present an algorithm to calculate a recruitment index to be used as tuning fleet for the short-term forecast of the Western Baltic cod. This approach is based on the sampling of pound net fishery in Denmark and Germany (see chapter 3.2.2.2, chapter 11 (Annex 6))

The data series was founded in 2008. Therefore, the algorithm presented in this chapter is preliminary and if more data will be available it has to be further investigated before it can be used in the assessment (e.g. if variation estimates are available)

In the recent assessment of western Baltic cod (ICES 2008b), in the short-term forecast (RCT3) four tuning fleets were used for Baltic cod recruitment estimates (Tab. 12). These tuning fleets have a poor performance concerning youngest age group (Fig. 29). It is assumed, that the surveys do not cover the spatial distribution of 0-group cod appropriately.

Tab. 12: Tuning fleets of Baltic cod stock assessment used in the short-term forecast (ICES, 2008b)

| Fleet | Year range | Age range |
| :--- | :--- | :--- |
| "Solea", Q4, SD22-24 | 1978-present | age 0 |
| "Solea", Q4, SD22-24 | 1977-present | age 1 |
| "Havfisken", Q1, SD22-23 | 1994-present | age 1 |
| "Havfisken", Q4, SD22-23 | 1994-present | age 0 |



Fig. 29: The present correlation between the 0 group from the two scientific surveys and the outcome of age 1 (back shifted) from the assessment

The new data series and hence the recruitment index should meet following requirements:

1. The data series should have a long-term perspective; it should be resistant, concerning changes of the spatial distribution of 0-group western Baltic cod Therefore:
a) we advise to record three different time series of pound net fishery, one for each location (Funen, Lolland, Fehmarn)
b) it is necessary to gather samples at as much sites per location as possible
2. the size range of 0-group has to be covered totally Therefore: size limit of size class I (small cod) should be expanded to 25 cm
3. the sample size for laboratory analyzes has to be raised to at least 100 individuals or 5 kg per sample, to achieve represent samples (i.e. appropriate length distributions)

Calculation of the indicator:

1. The number of cod in size group $1(<25 \mathrm{~cm})$ potentially include specimen from age group 0 and age group 1 . To gather the true number of 0 -group cod caught in pound nets, a correction is necessary. The proportion of 0-group cod has to be investigated from otolith readings of laboratory samples.

Equation 1: $\quad \mathrm{CPUE}_{0 \text {-group }}=\mathrm{CPUE}_{\text {sample }}{ }^{*} \mathrm{P}_{0 \text {-group }}$ whereby $\mathrm{CPUE}_{0 \text {-group }}$ is the number of cod of age group 0 per fishing activity; CPUE ${ }_{\text {sample }}$ is the number of cod in size group 1, recorded by fishermen; $\mathrm{P}_{0 \text {-group }}$ is the proportion of small cod in laboratory sample which corresponds to area and date of CPUE sample
2. The corrected $\mathrm{CPUE}_{0-\mathrm{group}}$ of all sites per location (Lolland, Funen and Fehmarn) should be averaged for the entire season, resulting in mean location CPUE (CPUE ${ }_{\text {loc }}$ )

Equation 2: $\quad \operatorname{CPUE}_{\text {loc }}=\Sigma C P U E_{0-\text { group,loc }} / n_{i, \text { loc }}$ whereby $\mathrm{CPUE}_{0 \text {-group,loc }}$ is the number of cod of age group 0 of fishing activity at location loc; $n_{i, l o c}$ is the number of recorded catches at location loc
3. For all three locations (Lolland, Funen and Fehmarn), an index (index ${ }_{\text {loc }}$ ) will be calculated

Equation 3: $\quad$ meanCPUE ${ }_{\text {loc }}=\Sigma C P U E_{\text {loc, years }} / n_{\text {loc, years }}$
whereby meanCPUE ${ }_{\text {loc }}$ is the mean of $\mathrm{CPUE}_{\text {loc }}$ of all years at this location (CPUE ${ }_{\text {loc, years }}$ ) and $n_{\text {loc, years }}$ is the count of years for which CPUE $_{\text {loc }}$ are available at this location

Equation 4: $\quad$ index ${ }_{l o c}=\left(\mathrm{CPUE}_{\mathrm{loc}} /\right.$ meanCPUE $\left._{\mathrm{loc}}\right) \quad-1$
4. An overall index for a given year (index) will be calculated

Equation 5: $\quad$ index $=$ index $_{\text {Ioc }} / \mathrm{n}_{\text {loc }}$ whereby index ${ }_{\text {loc }}$ are the indices for every location (which is available for this year) and $\mathrm{n}_{\mathrm{loc}}$ the number of location for which an index is available for this year.

### 3.4 Task 4: Coordination

Responsible partner: OSF (Germany)
This task covered the coordination of the whole project, which was running parallel to the other tasks, for the whole duration of the project. This task included:

- communication of plans and results to the EU commission, the stakeholders, the scientific community and the public at large
- organisation of workshops and internal project meetings
- compiling the design phase and the interim/final reports and
- coordination of national implementation programmes


## 4 Evaluation of project performance

### 4.1 Organizational changes

Danish Institute for Fisheries Research (DIFRES)
The Danish Institute for Fisheries Research (DIFRES) became part of the Technical University of Denmark (DTU) by January $1^{\text {st }} 2007$. The new name of the Institute is:

Technical University of Denmark
National Institute of Aquatic Resources (DTU Aqua)

Federal Research Centre for Fisheries / Institute of Baltic Sea Fisheries Rostock (IOR)

The Federal Research Centre for Fisheries will be part of the newly established Johann Heinrich von Thünen-Institut (vTI), Federal Research Institute for Rural Areas, Forests and Fisheries, by January $1^{\text {st }} 2008$. The new name of the institute is:

Johann-Heinrich von Thünen-Institute (vTI)
Federal Research Institute for Rural Areas, Forests and Fisheries
Institute of Baltic Sea fisheries

### 4.2 Key points for self-sampling programmes

As mentioned in chapter 3.2.1, six key points for self-sampling programmes were identified by ICES (2007) and Johnson and Densen (2007). Within JOIFISH/Lot8, it was aimed to take those critical aspects into account:

1. good communication:

The communication between project participants, i.e. scientist and fishery was a central aspect of JOIFISH/Lot8 from the very beginning. Several communication pathways were established during the project:
a) Baltic Fisheries Dialogue Meetings as basis for further communication
b) Articles in relevant fishermen's magazines to inform a broader public about the goals of JOIFISH/Lot8, to search for participants, and to inform fishery about the progress of JOIFISH/Lot8
c) Project scientists met with representatives from fishery organizations to inform them about the project and to discuss further steps
d) All participating fishermen were contacted regularly by scientists before, during and after the implementation phase.
e) Most fishermen have frequently contacted scientists to discuss problems and to report progress.
2. survey design:

Ideally, fishers should contribute significantly to project planning and design (Johnson and Densen 2007). The different sub-projects of JOIFISH/Lot8 were designed in cooperation between scientists and participating fishermen (for more detailed explanation and discussion, see chapter 3)
3. training:

If necessary (e.g. reference fleet, Glmp), it was aimed to train participating fishermen directly by responsible scientists. Unfortunately, it was not possible to organize training meetings of all participating fishermen on national level. Therefore, the training was done directly on the vessels of the participating fishermen.

## 4. confidentiality:

Due to intensive communication (meetings and regular phone calls), a good trust based relation relationship was established between project participants (i.e. scientist and fisherman) in most cases.
5. creating incentives for fishermen:

During JOIFISH/Lot8, several approaches to incentivise the involvement of fishermen were applied:
a) no financial incentive

Participants of the reference fleet did not receive any financial compensation for their effort to document their fishing activity and catch composition (see chapter 3.2.1.1).
Fishermen participating in the reference fleet expressed their opinion that fishery assessment does not incorporate the knowledge of fishermen in an optimal way. Therefore, they would like to contribute to broaden the data basis for fisheries management and to establish a more realistic view of the living resources and fishery.

Unfortunately, this incentive is not very strong and underlies some "mood cycles". This relative weak and "fuzzy" incentive is probably not the best basis to establish a time series long enough to be used within stock assessments.
b) financial compensation

Fishermen, who have sampled the (i) length distribution of cod (chapter 3.2.1.2) and (ii) pound net fishery (chapter 3.2.2.2) received financial compensation. Additional financial compensation was paid as charter fee for vessels used for cod recruitment surveys (iii) (chapter 3.2.2.1).
Whereas compensation for (i) and (iii) was calculated to reflect the effort required to conduct the task, the compensation for (ii) was more a gesture (in agreement with fishery).
Whereas, the compensation for (i) was calculated, discussed and agreed between scientists and participating fishermen, it was difficult to find fishermen who were willing to finally conduct this sampling. On the other hand, it was no problem to find vessels for the cod recruitment surveys.

As consequence, financial compensation by itself is not enough to keep selfsampling running (see (i)). But, it may help to smooth out some "mood cycles", as mentioned above, and to establish responsibility to conduct self-sampling on a professional level.
c) other compensations

Other forms of compensations were offered by Poland's Discard Project "Determining the magnitude of discards in the Baltic cod catches and further actions with regards to them if no-discards fisheries is implemented" (chapter 3.2.3). Especially benefits related to available quota were helpful to establish this programme.
Whereas it may be not possible to use such fundamental benefits for other jointcooperation projects, a compensation in terms of an additional quota for participating vessels was successfully implemented by other self-sampling programmes, such as the Norwegian Reference Fleet (ICES 2007 and ICES 2008a). In Norway, a small part of the national quota is kept back as "research and surveillance quota" and used to compensate participating fishermen and to finance the self-sampling programme. Consequently, this approach has no direct influence on the amount of caught fish and does not require significant amounts of additional public money.

### 4.3 Feedback from fishermen

As mentioned above, the participation of fishermen involved in JOIFISH/Lot8 activities at the $2^{\text {nd }}$ Baltic Fisheries Dialogue Meeting in Karlskrona (Sweden) was sparse. Two main reasons are given:

- the linguistic barrier (especially for German fishermen)
- the problem to find a suitable meeting date since cod fishing in the Western Baltic was quite bad in quarter 3 in 2008. Therefore, fishermen had to seize every fishing day.

As the $2^{\text {nd }}$ BFD was planned as feedback-workshop, following alternative approaches were used to sample this information:
a) personal contact (e.g. visits of scientist onboard of fishing vessels)
b) development of a questionnaire to analyse and evaluate the project

Especially, the questionnaire was intended as alternative for a final meeting.
This "Questionnaire for the analysis and evaluation of co-operation between fishermen and scientists in the project JOIFISH/LOT8" (chapter 7.6/annex 2) was filled out from participating fishermen in Germany and Denmark. (Swedish fishermen did not reply so far).

In this questionnaire qualitative as well as quantitative aspects were considered and it was structured in the following way:
I. information/statements about JOIFISH/Lot8 in general
II. information/statements about reference fleet: protocols
III. information/statements about the use of Greenlandic measuring protocol
IV. information/statements about pound net fishery

For the evaluation of the questionnaire it has to be pointed out that a statistical analysis was not possible due to the small group of participating fishermen. But general trends and criticisms of fishermen were reflected.

Several aspects from the direct contacts and questionnaire were included in previous chapters. Additional aspects are given below:

In Germany eight fishermen responded to the questionnaire. Most of these fishermen have already worked together with scientists. All fishermen were of the opinion that during the whole project the communication with the scientists was good. All fishermen are interested in a further cooperation with the institute. All fishermen agreed that JOIFISH/Lot8 significantly improved the dialogue between fishery and science.

At present, Sweden has not received any formal feedback from the fishermen from the questionnaires. In general the fishermen are rather slow in responding to written questionnaires. Interviews will be held in person on the nearest possible occasion. The overall impression is that the fishermen are open-minded with respect to the project. They are still reporting the discards even though the project has formally ended.

### 4.4 Problems encountered

## Late start of the project - shifting of activities

Due to a delay in the project start (scheduled for January 2007, started in May 2007), the planned workshop ("1st Baltic Fisheries Dialogue") was shifted from project month $5 / 6$ to project month 2 . Therefore, the scope of this meeting had to be changed from presentation of results/planning and final agreement to a first "brainstorming".

The design phase for the in situ implementation was finished after 7 months (planned in 6 months) at the end of 2007. The acquisition of the reference fleet started in January 2008. The development and implementation of the self sampling programs and a "proof concept" during the implementation phase shifted into spring 2008 and required more time than expected.

The implementation phase was hampered by extraordinary low fishing effort during summer and autumn 2008 (due to very low catches of cod in the Western Baltic Sea). Hence, the data collection required more time and ended in December 2008.

The first joint survey to investigate the year class strength of Baltic cod was conducted by Germany. This pilot survey was necessary to evaluate principle aspects of a joint cod recruitment survey. A second survey was conducted in Germany and Sweden in November 2008. Bad weather conditions hampered cod recruitment surveys in both seasons (see chapter 3.2.2.1).

## Status of communication between fishery and science

Poland - At the start of JOIFISH/Lot8, there was a serious disagreement between Polish fishermen and scientists. Fishermen are questioning the reliability of the stock assessments resulting in low level of quotas. Based on the level of their catch quota, fishermen believed that the stock of eastern cod is in a much better condition than estimated by scientists. On the other hand they do not question the fact that there is no cod with higher age in the Baltic and the majority of their catch consists of 2-4 year old fish. Nevertheless, the Polish discard study was conducted successfully.

Sweden - The situation in Sweden was also difficult, although the collaboration for data collection projects started again after the suspension of the latest cod fishing ban and scientists were accepted on board. After the change in allocation of tasks to the Karlskrona laboratory, the communication became better and Sweden was able to start the implementation of the reference fleet and cod recruitment survey.

### 4.4.1 Problems in Denmark

It was not very difficult to find Danish fishermen willing to participate in this project. However, to keep the motivation of fishermen - without compensation for their extra work - was a big challenge. In case of implementing a self- sampling program in Denmark on a regular basis, via a reference fleet or pound net sampling, a payment for fishermen would be mandatory. The communication of the results to the fishermen seems to be very important for the fishermen's willingness to stay in the project.

### 4.4.2 Problems in Sweden

The start of JOIFISH/Lot8 in Sweden was difficult, since the relationship between fishery and science was problematic at that time. Therefore, the project had a slow start. The situation changed when the Karlskrona Lab took the responsibility for Sweden.
The lesson learned was, that it is very important to approach fishermen on a regional basis and by personal contacts to establish trust. The observers working in the Data Collection Programme were very useful in creating the necessary contacts as they had experience in working with the fishermen.
The $2^{\text {nd }}$ BFD meeting was a success in the case that a key person in the fisherman's organisation was engaged in the cod recruitment survey (CRS). His positive experience with the project will be spread among the members of the organisation.

To involve fishermen in an early planning stage of the sampling might help to increase the involvement of the participants. Touching on matters regarding the fishermen's day-to-day life is another key issue to establish trust. For example one fisherman continuously recorded how much was eaten by seals in the gillnets. By doing this he estimated a special discard rate. To get a full picture on this source of discard would, however, require the further participation of all fishermen.

### 4.4.3 Problems in Germany

The project staff changed during the duration of the project. The close and trust based co-operation relies on a good personal contact between all involved participants. If contact persons change, these relationships have to be established again. This problem was solved due to the excellent of work of all participants.

Linguistic barriers are problematic for some German fishermen with respect to international project meetings. Therefore, national meetings may be the best way to bring fishermen together.

## 5 References

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## 6 Annex 1: Baltic Fisheries Dialogue (BFD)

## 6.1 "1 ${ }^{\text {st }}$ Baltic Fisheries Dialogue"

## List of participants



Fig. 30: Participants of the $1^{\text {st }}$ Baltic Fisheries Dialogue (second day)
Tab. 13: List of participants

| Name | Country | Organization | Group |
| :--- | :--- | :--- | :--- |
| Jörn Paustian | Germany | Fischereigenossenschaft Fehmarn | Fishery |
| Gerhard Rudolphi | Germany | Ministry of Agriculture, Environment and Consumer Protection | Government |
| Gerhard Martin | Germany | Ministry of Agriculture, Environment and Consumer Protection | Government |
| Christopher Zimmermann | Germany | Institute of Baltic Sea Fisheries | Science |
| Rainer Oeberst | Germany | Institute of Baltic Sea Fisheries | Science |
| Michael Andersen | Denmark | Danish Fisheries Association / Baltic RAC | Fishery / BS RAC |
| Kim Hansen | Denmark | Danish Fisheries Association / Baltic RAC | Fishery / BS RAC |
| Zbiegniew Karnicki | Poland | Sea Fisheries Institute Gdynia | Science |
| Christian Pusch | Germany | Federal Agency for Nature Conservation | Science |
| Marek Gzel | Poland | Fishing Shipowner's Association Koloberg | Fishery |
| Marie Storr-Paulsen | Denmark | Danish Institute for Fisheries Research | Science |
| Henrik Degel | Denmark | Danish Institute for Fisheries Research | Science |
| Joakim Hjelm | Sweden | Swedish Board of Fisheries | Science |
| Daniel Stepputtis | Germany | Institute of Baltic Sea Fisheries | Science |
| Tomas Gröhsler | Germany | Institute of Baltic Sea Fisheries | Science |
| Uwe Böttcher | Germany | Institute of Baltic Sea Fisheries | Science |
| Katrin Paul | Germany | Institute of Baltic Sea Fisheries | Science |
| Christian von Dorrien | Germany | Institute of Baltic Sea Fisheries | Science |
| Peter Breckling | Germany | German Fisheries Association | Fishery / BS RAC |
| Kai-Arne Schmidt | Germany | Kutterfischzentrale Cuxhaven | Fishery |
| Norbert Kahlfuss | Germany | Landesverband der Kutter-und Küstenfischer Mecklenburg-Vorpoemmern | Fishery / BS RAC |
| Harry Strehlow | Germany | Institute of Baltic Sea Fisheries | Science |
| Cornelius Hammer | Germany | Institute of Baltic Sea Fisheries | Science |
| Norbert Schulz | Germany | Verein Fisch und Umwelt e.V. | Science |


| Magnus Appelberg | Sweden | Swedish Board of Fisheries | Science |
| :--- | :--- | :--- | :--- |
| Teija Aho | Sweden | Swedish Board of Fisheries | Science |
| Lothar Fischer | Germany | German Cutter-and Coastal-Fishermen's Association | Fischery / BS RAC |

## Meeting Agenda

Tuesday 19 June 2007

| $20: 00$ |  | Warming-up drink |
| :--- | :--- | :--- |

Wednesday 20 June 2007

| $09: 00$ | Dr. Gerhard Rudolphi | Welcome note by the Minister Dr.Till Backhaus |
| :--- | :--- | :--- |
| $09: 30$ | Cornelius Hammer | Opening Adress, 5 key problems as identified by the science <br> and fishery |

Session 1: "Joint collection - a way to help each other?" Chair: T.Gröhsler, D.Stepputtis

| $10: 00-10: 30$ | Daniel Stepputtis | EU-Lot8 (JOIFISH): Joint collection of data and self-sampling of <br> information by the fishery |
| :--- | :--- | :--- |
| $10: 30-11: 00$ |  | Discussion |
| $11: 00-11: 30$ | Henrik Degel, <br> Michael Andersen | Danish experience of sampling cooperation |
| $11: 30-12: 00$ |  | Discussion |

Session 2: "New approaches?" Chair: C.Hammer, G.Martin

| $13: 30-14: 30$ | Cornelius Hammer | Cod stocking in the Baltic: COBALT project |
| :--- | :--- | :--- |
| $14.30-15: 30$ |  | Discussion, Coffee |
| $15.30-16: 00$ | Uwe Böttcher | Use of VMS-data - to the benefit of the fishery? |
| $16: 00-16: 30$ |  | Discussion |


| $20: 00$ |  | Informal Dinner with many discussions |
| :--- | :--- | :--- |

Thursday 21 June 2007

| 08:00-09:00 | Kick of meeting of the working group to identify most important <br> tasks of joint cooperation and to discuss further steps <br> (JOIFISH/Lot8) |
| :--- | :--- | :--- |

Session 3: "Recovery"

| $09: 00-09: 30$ | Peter Breckling | Cod recovery Clan for the Western Baltic Sea |
| :--- | :--- | :--- |
| $09: 30-10: 15$ |  | Discussion |
| $10: 15-10: 45$ | Magnus Appelberg | Trophic cascades in the Baltic |
| $10: 45-11: 15$ | Christian von Dorrien | EU-Project UNCOVER: State of the art and perspectives of <br> recovery for the Baltic Sea |
| $11: 15-11: 30$ |  | Discussion |


| Session 4: "Less discards and less regulations?" |  | Chair: C.Zimmermann, J. Paustian |
| :--- | :--- | :--- |
| $11: 30-12: 00$ | Joakim Hjelm | Kattegat effort project - What are the problems of changing the <br> perspectives of fisheries management? - TAC versus effort <br> control |
| $12: 00-12: 30$ | Christopher Zimmermann, <br> Jörn Paustian | The Fehmarn Discard-Project |
| $12: 30-13: 00$ |  | Discussion |

Wrapping up

| $13: 30-14: 00$ | Cornelius Hammer | Discussion and wrapping up: " 5 problems - 5 solutions?" |
| :--- | :--- | :--- |
| $14: 00-14: 30$ |  | Discussion |
| $14: 30-$ |  | Individual discussions |

## 6.2 " $2^{\text {nd }}$ Baltic Fisheries Dialogue"

## List of participants



Fig. 31: Participants of the $2^{\text {nd }}$ Baltic Fisheries Dialogue (second day)
Tab. 14: List of participants

| Name | Country | Organization | Group |
| :--- | :--- | :--- | :--- |
| Alex Olsen | Denmark | A.Espersen (DFE) | Fishery |
| Cecile Kvaauik | Denmark | DTU Aqua | Science |
| Christopher Zimmerman | Germany | Institute of Baltic Sea Fisheries | Science |
| Daniel Stepputtis | Germany | Institute of Baltic Sea Fisheries | Science |
| Håkan Wennhagen | Sweden | IMR Sweden | Science |
| Jörn Paustian | Germany | Fischereigenossenschaft Fehmarn | Fishery |
| Kim kear Hansen | Denmark | DK Fishermen Association | Fishery |
| Marie Storr-Paulsen | Denmark | DTU Aqua | Science |
| Mattias Sköld | Sweden | IMR Sweden | Science |
| Norbert Schulz | Germany | Fisch und Umwelt MV e.V. | Science |
| Olle Viberg | Sweden | Fiskare SFR | Fishery |
| Petra Jantschik | Germany | Institute of Baltic Sea Fisheries | Science |
| Ronny Weigelt | Germany | Institute of Baltic Sea Fisheries | Science |
| Tomasz Linkowski | Poland | MIR Gydina | Science |
| Yvonne Walther | Sweden | IMR Sweden | Science |
| Zbiegniew Karnicki | Poland | MIR Gydina | Science |
| Olle Brus | Sweden | IMR Sweden | Science |
| Hans Jonasson | Sweden | IMR Sweden | Science |
| Fredrik Nilssen | Sweden | IMR Sweden | Science |

## Meeting Agenda

## Thursday 9 October 2007

| 10:00 - 10:30 | ??? and Yvonne Walther | Welcome |
| :--- | :--- | :--- |

Session 1: "Joint collection - away to help each other?"
Chair: Daniel Stepputtis

| $10: 30-11: 00$ | Petra Jantschik | EU-Lot8: Joint collection of data and self-sampling of information by the <br> fishery |
| :--- | :--- | :--- |
| $11: 00-11: 30$ | Ronny Weigelt | Cod Recruitment survey: A new joint research project between fishery and <br> fishery science |
| $11: 30-12: 00$ |  | Discussion |
| $13: 00-13: 30$ | Daniel Stepputtis | How to establish a feedback and information procedure between fisheries <br> and science? |
| $13: 30-14: 00$ |  | Discussion |
| $14: 00-14: 30$ | Håkan Wennhagen | Planctivore management project - alternative management strategies |
| $14: 30-15: 00$ |  | Discussion |

Session 2: "Traceability and fully documented Fishery"
Chair: Marie Storr-Paulsen

| $15: 00-15: 15$ | Marie Storr-Paulsen | Danish video system |
| :--- | :--- | :--- |
| $15: 15-15: 30$ | Mattias Sköld | Scientific use of VMS |
| $15: 30-16: 00$ |  | Discussion |
| $16: 00-16: 15$ | Alex Olson | Responsible sourcing - The importance of traceability system |
| $16: 15-16: 30$ |  | Discussion |


| $16: 30-17: 30$ | detailed discussions JOIFISH/Lot8 |
| :--- | :--- |


| 19:00 | Informal dinner with many discussions |
| :--- | :--- |

## Friday 10 October 2007

Session 3: " New management strategies?"
Chair: Christopher Zimmermann

| $09: 00-09: 30$ | Christopher Zimmermann | New management strategies - a summary |
| :--- | :--- | :--- |
| $09: 30-10: 00$ | Steve Karnicki | Determining the magnitude of discard in Baltic cod catches and further <br> action with regard to them if no-discard fisheries is implemented. |
| $10: 00-10: 30$ |  | Discussion |
| $10: 30-11: 00$ | Kim Kear Hansen | A new management strategy in Denmark - report of experience |
| $11: 00-11: 30$ |  | Discussion |

## Wrapping up

| $11: 30-12: 00$ | Daniel Stepputtis | Discussion and wrapping up about the 2nd BFD; Future of the BFD |
| :--- | :--- | :--- |
| $12: 00$ |  | Individual discussions, JOIFISH/Lot8-participant meeting |

## 7 Annex 2: Protocols and Instructions

Protocols and instructions are translated into English from national languages.

### 7.1 General instructions for self-sampling

## Contact persons at the Institute:

## Specific for countries

## The reference fleet protocol

Every catch/haul shall be documented in the reference fleet protocol which was designed in the project JOIFISH/Lot8. Obligatory information are: date, catch position, gear (gillnet fishery: type, number of nets, mesh size, height of the net; trawlnet fishery: net type, mesh size, selective device [Bacoma, T90]) and weather.

## Reporting about fish

The total catch and bycatch of fish shall be reported on the reference fleet protocol (landings and discards). It is possible to write the weight of landings in gutted weight or in live weight. Discard estimates should be carried out in accordance with the relevant instructions (see annex). The goal is to record the total catch composition, including non-commercial species.

## Completing the protocol

The comments field at the bottom of the sheet can be used if there are any special issues that should be highlighted (e.g. weight of subsamples, net damages). There is the possibility to make a short note about by-catches of marine mammals and seabirds in the comments field of the protocol. The German Museum for Marine Study and Fisheries could be informed by watching or catching seals or whales (see annex)

## Instructions for biological sampling (length measurements)

Cod is the target species of this self-sampling program and shall be measured in every $10^{\text {th }}$ haul. The Greenlandic length measuring paper (this paper protocol was developed in Greenland) is placed on a board and enables one person to measure fish alone, as the length of the fish is marked directly on to the paper strip. Length measurements should be carried out in accordance with the relevant instructions (see annex).

## Annex

- Reference fleet protocol for fishing with gillnet and fishing with trawlnet (German version)
- Instruction for the discard estimation
- Measuring instruction for working with Greenlandic length measuring paper (GImp)
- Protocol for information of finding or watching seals or whales at the beach or in waters at the German Museum for Marine Study and Fisheries
7.2 Reference Fleet: haul protocol


Fig. 32: Reference fleet - haul protocol by fishing with trawl net

|  |  |  |  | Referenzflotte |  |  | Holprotoko |  | Il - Schleppnetz |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Schiff: |  | Tümmler |  | FKZ: |  |  |  |  | Protokollant: |  | $\square$ |  |  |  |  |
|  |  |  | Position |  |  |  | Netz |  | Vornetz |  | Steert <br> $\substack{\text { Maschen- } \\ \text { offrung } \\ \text { mm }}$ | Wetter (siehe Rückseite) |  |  |  |
| $\stackrel{5}{2}$ |  |  | Breite | Länge | Wassertiefe | Geschw. | Typ | Selekkionstyp | Maschen-anzah\| | Maschen- |  | Wind |  | $\begin{gathered} \text { Wellen- } \\ \text { hôhe } \\ \mathrm{m} \end{gathered}$ | Wetter |
|  | ttmmij | hh:mm | - 'N | - 'E | m | kn | z.B. РTе, отв | $\begin{gathered} \text { z.B. Bacoma, } \\ \text { T90 } \\ \hline \end{gathered}$ | mm | mm |  | Richtung | Starane |  |  |
| 1 | AOHang 109 | $0710$ | $\frac{54.14}{\operatorname{Nin}}$ | $\begin{aligned} & 10420 \\ & \min 2428 \end{aligned}$ | Min 21 | Mir 2,9 | 0 OB | Baroma | $2 \times 160 \times$ Uimfang | 120 | 105 | SO-NO | 0-1 | 0 | $2 / 7$ |
|  | EYdenca | 11130 | $\underset{\max }{5418}$ | $\mathrm{O}_{\operatorname{Max}} 28$ | max 22 | $\operatorname{Max}^{3}, 1$ |  |  |  |  |  |  |  |  |  |
| 2 | Anfang | $\begin{aligned} & 0730 \\ & \text { Anfang } \end{aligned}$ | $54.15$ | $04115$ | $\operatorname{Min}^{2} 21$ | Min2, y | OTB | Broma | -11- | -11- | -11- | NW | 0-1 | O | 4 |
|  | Eherel09 | 11130 | 5421 | 01122 | Max 22 | $\max ^{3}, 1$ |  |  |  |  |  |  |  |  |  |
| 3 | 240n9 0109 | Antion | min $\mathrm{min}^{\text {a }}$ | 2in 14 | min 20 | Min $x^{3}$ | 013 | Becoma | -11- | - $11-$ | - $11-$ | SU | $3-4$ | 0,5 | $2 / 6$ |
|  | 2408109 | Enbe 20 | $\mathrm{chax}_{21}$ | Max 20 | max 2 | $\max ^{3}, 1$ |  |  |  |  |  |  |  |  |  |
| Fang jeder Art an Bord in kg |  |  |  |  |  |  |  |  |  |  |  | Bemerkungen |  |  |  |
| $\begin{aligned} & \stackrel{y}{\text { ¹}} \\ & \text { 호 } \end{aligned}$ |  | Dorsch $\square \mathrm{vmK}$国 amK | Flunder EvmK $\square \mathrm{amK}$ | $\begin{gathered} \hline \text { Scholle } \\ \square \mathrm{vmk} \\ \text { amk } \end{gathered}$ | Kliesche $\square \mathrm{vmK}$ Damk | Wittling $\square \mathrm{vmk}$ EKamk | Steinbutt $\square \mathrm{vmk}$ ® $\times$ amk | $\square \mathrm{vmk}$ <br> ㅁamk | $\square \mathrm{vmk}$ <br> $\square$ amk | ㅁvmk <br> $\square \mathrm{amK}$ | $\square \mathrm{vmk}$ <br> $\square \mathrm{Damk}$ |  |  |  |  |
| 1 | Anlandung | 123 | 63 | 13 | 154 | 40 ( 1 | 7 |  |  |  |  | Dash Fangericha 154 Discoul gewojen |  |  |  |
|  | Discard | 3,5(wmk) | 2 (vink) | 1 (umk) | $27($ unk) | 40 (umk) | $7(\mathrm{vm} / \mathrm{k})$ |  |  |  |  |  |  |  |  |  |  |
| 2 | Anlandung <br> Discard | 202 | 53 | $\frac{7}{0,5(\text { vin })}$ | 37 $10(\sin$ ) | $\frac{5}{1(\text { unk })}$ | $\frac{3}{2(u m k)}$ |  |  |  |  | Duad Frungenicdt 256 |  |  |  |
| 3 | Anlandung <br> Discard |  | 29 $1(\operatorname{um} k)$ |  | $\frac{53}{(\sin k)}$ | $\begin{gathered} 1 \\ 1(\text { unk }) \end{gathered}$ | 1,5 |  |  |  |  | Unterubs: Fang ganilt 197 |  |  | +197 160 |
| Kontakt: Institut für Ostseefischerei, Alter' Hafen Süd 2, 18069 Rostock, Tel.: 0381/8116100 Petra Jantschik: Petra.Jantschik@vti.bund.de, Tel.: 0381/8116126 Ronny Weigelt: Ronny.Weigelt@vti.bund.de, Tel.: 0381/8116126 |  |  |  |  |  |  |  |  | Daniel Stepputtis (Projektkoordinator), Tel.: 0381/8116136 Daniel.Stepputtis@vti.bund.de <br> Diccul genergan |  |  |  |  |  |  |

Fig. 33: Reference fleet - completed haul protocol by fishing with trawl net


Fig. 34: Reference fleet - haul protocol by fishing with gillnet


Fig. 35: Reference fleet - completed haul protocol by fishing with gillnet


Fig. 36: Reference fleet -code to fill out the haul protocol

### 7.3 Instructions for the discard acquisition

## Fishing by gillnet

Usually, discards in gillnet fisheries are low. Therefore, all discards shall be collected (undersized and unwanted species) in boxes or baskets. The full boxes or baskets shall have an approximately known weight if it is not possible to weight them on board. After the processing of marketable fish, please sort and weigh discards.
Note: Make a short note, how the discard is defined: weighed or estimated!

## Fishing by trawlnet

Both the amount of bycatch and discard and the methods of fish processing on board can vary significantly in trawlnet fishing. Furthermore, there is a large size range in the fishing boats that makes it difficult to develop a standard sampling scheme for the determination of discards.

The crucial factor is the amount of discard by hauls.
i) If there is little discard: all discards shall be sampled in a box / basket, sorted after species and weighed (or estimate weight). (see 'fishing by gillnet')
ii) If there is a relative high amount of discard: take a representative sample. The fish are seldom homogeneous distributed in the catch (e.g. bigger fish can be found in the upper part of the catch). Therefore, it is optimal if the sub-sample is taken from different fractions of the catch. Depending on what is possible, approx. 1/3 of the sub-sample should be taken from the first part from the haul, approx. $1 / 3$ should be taken around half of the catch processing and approx. $1 / 3$ the last part.

For an optimal estimation of discard, the knowledge of the fisherman and the technical possibilities on board are crucial. Therefore, the instructions for the discard acquisition are quite general.

Take a representative sample during the processing of the catch, as described above. It is advisable to choose a typical sorting unit for that (e.g. a charge of the sorting board or a standard box). Please, sort and weigh this sample by species for landings and discards (If it is possible write the weight of this sample on the reference fleet station protocol in the field "notes"). During the further processing the other/residual discard (amount and weigh) will be estimated. After the processing of marketable fish the weight ratios will be transferred on the total catch.
e.g. 10 baskets are measured/analyzed and total 100 baskets are filled
$\rightarrow$ all weights multiply with 10

To quantify the total amount of discarded cod we need the information on

1) total weight of the catch
2) total weight of landed cod
3) total weight of discarded cod, if a sub-sample of the discard is taken, the weight of the sub-sample and the fraction of total discard is needed.

Note: Make a short note, how the discard is defined: weighed or estimated!

### 7.4 Instructions for biological sampling - length measurements

## Instructions for working with Greenlandic length measuring paper (GImp)

## General introduction

The main principle in fish sampling is that the sub-sample should reflect the total catch. Fish designated for measuring should present all length groups, not a disproportional high number from a single length group (e.g. very small or very large fish). The aim of the sampling is to show the real relationship of length groups in the total catch.
Within the scope of the project JOIFISH/Lot8 cod is in the focus of sampling.
Every 10th catch/haul shall be measured.

For futher analysis, it si necessary to fill out the reference fleet protocol as well.

## Installation of the measuring paper

Before the measuring procedure begins, wet the board for a better paper grip on the measuring board. Then the measuring paper should be placed on the left edge of the board. The two perforations in the paper are in the same position as the two board spikes. So the paper will be fixed on the board. If the paper is longer than the board, you can turn the right paper end down and fix it with an elastic band (fig.1)


Fig. 37: Length measuring board in lateral and top view

## Further particulars on the measuring paper

The grey highlighted fields in table 1 are important for later analysis and must be completely filled. With this information we can assign the measuring paper to the corresponding reference fleet catch protocol. Only when all information is available, the sample can be processed further.

Tab. 15: Translation of the Danish Measuring Paper: grey highlighted field must be filled

| Danish | English | Explanation |
| :---: | :---: | :---: |
| Art | fish species |  |
| Skib | ship |  |
| Dato/Tid | date/time |  |
| Redskab | gear | e.g. OTB; GNS; PTB... |
| Udfyldt af | minute taker | same as in the catch/haul protocol |
| Traek nr. | catch nr. | discard + landings |
| Total vaegt i traek (målt art) | total weight of cod in the catch |  |
| Måleprøvens vaegt | weight of measured cod |  |
| ICES kvadrat | ICES rectangle |  |
| Antal øresten | number of otoliths |  |
| Renset vaegt | gutted weight |  |

## Length measurement

Place the fish in a natural position with the nose on the left edge of the board (Figure 1) and make a mark with a pencil on the paper where the tail ends (only a pencil can be used as everything else will be washed out with water). For later analysis it would be favourably, if the pencil marks are organized in groups of five marks, as you can see in Figure 2. For fish longer than 100 cm , please make a note on the paper ( $1=106 ; 1=102$ ) with the number of these large cods per 1 cm length group.


Fig. 38: Marks on the measuring paper

## Number of samplings when fishing with gillnets (passive gear)

If the total weight of the catch is less than 250 kg , you have to measure all caught cod (discards and landings).
In case of a catch larger then 250 kg , you have to measure 200 fishes. Take a representative subsample

## Number of samplings when fishing with trawlnet (active gear)

If the weight of total catch is less than 250 kg , then you have to measure all caught cod (discards and landings).
In case of a catch larger then 250 kg , two length measurements have to be carried out (both measurements can be done on one measuring paper, if both distributions are clearly separated by a mark):

1. Landings: 200 fish have to be measured. This sample should be representative for the total landed cod catch.
2. Discards: During work on board/sorting of the fish all cod designated for discard, have to be put into baskets. All cod from one of these baskets have to measured (however, maximum 200 fish) and the weight of this subsample has to be written on the measuring paper. You have to write the total weight of discarded cod (e.g. weight estimated by baskets) into the station protocol.
7.5 Pound net fishery


Fig. 39: Pound net haul protocol

### 7.6 Questionnaire for the analysis and evaluation

Questionnaire for the analysis and evaluation of co-operation between fishermen and scientists in the project JOIFSH "Joint data collection between the fishing sector and the scientific community in the Baltic Sea"

## General Data:

Name:
Vessel:
Method of fishery / fishing kind (fishing by gearnet or trawlnet):
target species:
Main fishing area:

## Information/statements about JOIFISH/Lot8

- How did the contact develop to institute and to the project JOIFISH/Lot8?
$\square$ active by the institute
$\square$ by indirect information about third e.g. fisheries organisation
$\square$ by information in Fishery journals
comment:
- Did you work before this project already once on scientific problem?

ㅁ yes
ㅁ no
comment:

- How does communication with the institute run and what can possibly be improved?

|  $\square$ $\square$ $\square$ $\square$  <br> 1 2 3 4 5  | $1=$ good <br> $5=$ bad |
| :--- | :--- | :--- | :--- | :--- | :--- |
| comment: |  |

- Do you feel always informed about the newest project conditions?
$\square$
- Are you interested in a further co-operation with the institute?
$\square$
- How do you estimate the sense and purpose of this feasibility study? (Please describe briefly!)

- Which are the positive experiences for you in JOIFISH/Lot8?
$\square$ improved dialogue with science
$\square$ a view of the scientific work and view and thereby a common discussion
ㅁ exchange of experiences
$\square$ other experiences: .....
- Which are your negative experiences in JOIFISH/Lot8: notes, problems and improvement suggestions
$\square$


## Reference fleet: Protocols

- How large is the expenditure to fill out the protocols and/or to give a data acquisition?

```
reference parameter: }\square\mathrm{ by day }\square\mathrm{ by haul
data acquisition (capture of discard) :
min
fill out the protocol:
                                min
```

- Which data in protocls are difficult to make?
$\square$ information about positions
$\square$ information about gear
information about the catch :landings discard
$\square$ information about weather
comment:
- How do you determine the quantity of Discard? (Please make a short description)
$\square$ through estimate
$\square$ through weigh the hole discards
$\square$ through take a subsample
comment:
- What could be improved at the protocols? (Please describe briefly!)
$\square$ clear arrangement
$\square$ remove "useless" data, specify please
$\square \quad$ change units and measure data
$\square$ other things......
- Would you fill out further protocols of the reference fleet?

```
\square yes
\square \mp@code { n o }
```

comment.

## Greenlandic measuring paper (GImp)

- Is the measuring of a Cod sample in principle on board possible?

| $\square$ yes | $\square$ no |
| :--- | :--- |
| comment: |  |

- Did you ever use this measuring board? If yes than answer the following questions!
ㅁ yes
ㅁ no
comment:
- How do you estimate the effort with the Glmp??

|  | $\stackrel{\square}{\square} \square_{2} \square_{3} \square_{4} \square{ }_{5}$ | 1 = too high <br> 5= acceptable |
| :---: | :---: | :---: |
|  | comment: |  |

- Where do problems arise when working with the length measuring board? (Please describe briefly!)


## Statements about poundnet fishery

- How do you evaluate co-operation with the institute in context with poundnet sampling this year?
$\left.\left.\begin{array}{|llllll|}\hline \square & \square & \square & \square & \square & \\ 1 & 2 & 3 & 4 & 5\end{array}\right) \quad \begin{array}{l}1=\text { good } \\ 5=\text { bad }\end{array}\right]$
- How do you estimate the effort of poundnet sampling for you this year?
$\square$ fine
$\square \quad$ could be less
$\square$ too much
comment:
- How do you judge the poundnet sampling in general this year?
$\square$ very good
$\square$ bad
$\square$ good, but with the following changes for next year
comment:
- notes, problems, ideas for improvement


## Thanks for your patience and co-operation!

## 8 Annex 3: Danish commercial tuning fleet

The new commercial tuning fleets were plotted against the former tuning fleet to observe if year-classes changed between the series. From these test it was shown that for nearly all year-classes same pattern were evident in the new tuning series and in the former. However, some differences were seen at age 6 between the series for both the trawlers and gillnetters.


Fig. 40: Left: Former Danish trawler tuning fleet in blue and new Danish specialist trawler fleet in pink by age groups and years.; Right: Former Danish gillnetter tuning fleet in blue and new Danish gillnetter fleet in pink by age groups and years.

Consistency analyses were conducted to test how good a year class could be followed between years and from this it was concluded that the gillnetters did not show a very good internal consistency and was therefore excluded in the final assessment. The consistency analysis of the new commercial trawlers showed however a fine internal consistency and was included in the final assessment (Fig. 41)


Fig. 41: consistency analyses fro tuning series. Left: trawler; Right: gilnetter




Fig. 42: Performance analyses of for different tuning fleets.
Sensitivity analysis were preformed on the different new commercial tuning fleets and compared to the assessment conducted in 2008 (ICES 2008b). The results showed that with a large shrinked as has been used in the assessment in 2008 the influence of the changed tuning fleet is of no importance for recruitment and SSB but fishing mortality is increased a bit implementing the new commercial fleets.

## 9 Annex 4: Cod Recruitment Surveys (CRS)

### 9.1 Cruise report for the $1^{\text {st }}$ CRS with BUR 6 „Tümmler")

I nstitute of Baltic Sea Fisheries

# Cruise report for the <br> $1^{\text {st }}$ Cod Recruitment Survey with fishing vessel BUR 6 „Tümmler" from 15.04. till 17.04. and from 24.04. till 25.04.2008 

Chief scientist: Antje Krieger

## 1. Background

The main problem with the current assessment of Baltic cod is the estimation of recruitment, especially of the age-groups 0 and 1. Consequently, there are uncertainties about those agegroups which will be fished within the next years. Fishery requested solutions for this problem during the " $1^{\text {st }}$ Baltic Fisheries Dialogue" held in framework of the EU - Project JOYFISH/Lot8 in June 2007 and hosted by the Institute for Baltic Fisheries in Rostock. Hereby cooperation between fishery and fishery science was recommended.
Fishermen reported that the juvenile cod could be found very close to the shore in water shallower than 20 meters primarily during spring.
Frequently, fishermen and fishermen's organization criticise the choice of wrong sampling time, wrong fishing gear and wrong sampling area (e.g. no coverage of areas shallower than 20 m ) for scientific surveys. On the other hand, it makes no sense to change periodical scientific surveys like the Baltic International Trawl Surveys (BITS) for a lot of reasons. The main reason is that the goal of such surveys is to establish long time series to identify changes in the ecosystem and fish stocks. Those time series need standardised methods, which are kept stable for long periods and which are coordinated internationally. Furthermore there are limitations in available ship time, as well as hauling positions in shallower water.
Consequently, the idea was born to establish a joint survey onboard a commercial fishing vessel. The $1^{\text {st }}$ Cod Recruitment Survey (CRS) started in April 2008 with two German commercial fishing vessels:

1. BUR 6 "Tümmler" in ICES SD 22 in the area around Fehmarn
2. SAS 29 "Petra B." in ICES SD 24 in the area around Rügen

Both surveys were carried out as feasibility studies as part of the EU-project JOIFISH/Lot8. They were characterised by:

- The skipper of the fishing vessel has selected sampling stations prior to the survey, whereby stations should be optimal to catch young cod. Thereby the experience of the fishermen is of great importance. This station selection could be used for later surveys as well. Thus a meaningful data acquisition of the cod stock for a long time
period would be possible and maybe it allows documenting year to year changes. The aim of that survey was to evaluate and check the possibility for such a survey on a commercial fishing vessel in order to get information about the year class strength of Baltic cod. On a long-term basis such data could be used as additional index for assessment of Western Baltic cod stock.
- The fishing gear suitable to catch cod recruits was selected and delivered by participating fishermen. Regarding a possible establishment of a time series it is necessary to use the same fishing gear also in the subsequent years.
- The investigation period was coordinated with the fishermen. Thus the fishermen experiences were of great importance.
The catches were analysed on board by scientific staff. Planning and data evaluation was conducted in cooperation with participating fishermen. They were also informed about the results. Furthermore, an optimization of following surveys will be discussed.


## 2. Tasks of the survey

- test of joint surveys between fishery and fishery research onboard of commercial fishing vessels
- sampling of data about the growth habitats and biological characteristics of cod recruits in the western Baltic Sea
- sampling of hydrographical data (temperature, oxygen content, salinity)


## 3. Cruise activities

One part of the $1^{\text {st }} \mathrm{CRS}$ in April 2008 was conducted with fishing vessel BUR 6 "Tümmler" (stern trawler, $14.80 \mathrm{~m}, 2200$ GRT, made of wood, year of construction: 1983, crew: 2 men). During the survey a custom-made eel trawl ( 40 mm mesh opening in the wing, 25 mm mesh opening in the codend) was used. In the sampling area (Fig.1, Tab.1) 25 hauls were conducted with a duration of 30 min each. Due to technical problems hydrographical measurements were carried out on 18 of 25 stations directly after heaving, whereby a CTD probe (CTP 004 from Sea and Sun Technologies) was used.
15.04: setting up BUR 6 "Tümmler" and fishing E and SE of Fehmarn, 5 hauls, N-NW wind, $1-3$ bft, $1 / 8$ till $6 / 8$ cloudiness, $2-8{ }^{\circ} \mathrm{C}$ air temperature
16.04: fishing $E$ and SE of Fehmarn and Fehmarnbelt, 5 hauls, NW wind, $1-3 \mathrm{bft}, 1 / 8$ till $3 / 8$ cloudiness, $4-7^{\circ} \mathrm{C}$ air temperature
17.04: fishing SE of Fehmarn and in the Bay of Lübeck, 5 hauls, N-NE wind, 1-2 bft, $7 / 8$ till $8 / 8$ cloudiness, $3-6^{\circ} \mathrm{C}$ air temperature
18.-23.04 stayed in harbour because of strong NE wind, 5-7 bft
24.04: fishing in Fehmarnbelt, 5 hauls, SE wind, $1-2$ bft, cloudless, $8-10{ }^{\circ} \mathrm{C}$ air temperature
25.04: fishing in the Bay of Lübeck, 2 hauls (day) and 3 hauls (night), circulating and SW wind, $0-1 \mathrm{bft}, 7 / 8$ till $8 / 8$ cloudiness, $8-10^{\circ} \mathrm{C}$ air temperature


Fig. 1: Sampling stations (Fehmarnbelt, E and SE of Fehmarn and Bay of Lübeck)

## 4. Results

### 4.1 Fishery

During the survey altogether 2533 kg fish were caught (Tab. 1.). Thereby the mix herring/sprat with 1186 kg represented the largest proportion. Total catch of cod was 454 kg , followed by whiting ( 421 kg ) and dab ( 356 kg ).

Tab. 1: Catch composition of 25 hauls divided by sampling areas.

| Date | Sampling area | Cod <br> (kg) | Herring /Sprat <br> (kg) | Whiting <br> (kg) | $\begin{aligned} & \text { Dab } \\ & (\mathrm{kg}) \end{aligned}$ | Flounder <br> (kg) | Plaice <br> (kg) | Turbot <br> (kg) | Rest <br> (kg) | Total catch (kg) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 15.04.08 | E and SE of Fehmarn | 85.00 | 47.00 | 174.50 | 55.80 | 6.50 | 3.55 | 1.25 | 0.42 | 374.07 |
| 16.04.08 | E of <br> Fehmarn and Fehmarnbelt | 77.40 | 266.00 | 19.00 | 71.90 | 3.10 | 3.55 | 1.70 | 1.76 | 444.65 |
| 17.04.08 | SE of Fehmarn and Bay of Lübeck | 117.30 | 136.30 | 29.10 | 66.80 | 4.95 | 2.20 | 1.30 | 2.71 | 342.80 |
| 24.04.08 | Fehmarnbelt | 29.12 | 736.33 | 3.30 | 93.17 | 4.86 | 4.50 | 1.79 | 0.15 | 873.11 |
| 25.04.08 | Bay of Lübeck | 145.27 | 71.26 | 194.95 | 68.90 | 15.55 | 2.44 | 0.00 | 0.00 | 498.36 |
|  | Total | 454.09 | 1256.89 | 420.85 | 356.57 | 34.96 | 16.24 | 6.04 | 5.03 | 2532.99 |

### 4.2 Cod recruits

On 25 sampling stations around Fehmarn and in the Bay of Lübeck altogether 4 cod recruits $<20 \mathrm{~cm}$ were caught (Tab.2, Fig. 4e).

Table 1: Location of sampling stations and number of cod recruits $\mathbf{< 2 0} \mathbf{~ c m . ~ ( * ~ n i g h t ~ f i s h e r y ) ~}$

| Date | Haul | Time | Sampling area | Latitude$\left({ }^{\circ} \quad \mathrm{N}\right)$ | Longitude | Number of cod (<20 cm) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | (hh:mm) |  |  |  |  |
| 15.04.08 | 1 | 07:15 | $E$ and SE of Fehmarn | $54^{\circ} 24.56{ }^{\prime}$ | 011 ${ }^{\circ} 24.53$ ' | 0 |
| 15.04.08 | 2 | 08:55 | $E$ and SE of Fehmarn | $54^{\circ} 24.80^{\prime}$ | 011 ${ }^{\circ} 28.40^{\prime}$ | 1 |
| 15.04.08 | 3 | 10:20 | $E$ and SE of Fehmarn | $54^{\circ} 23.80^{\prime}$ | 011 ${ }^{\circ} 33.40^{\prime}$ | 0 |
| 15.04.08 | 4 | 11:50 | $E$ and SE of Fehmarn | $54^{\circ} 20.80^{\prime}$ | 011 ${ }^{\circ} 29.00^{\prime}$ | 0 |
| 15.04.08 | 5 | 13:10 | $E$ and SE of Fehmarn | $54^{\circ} 18.10^{\prime}$ | 011 ${ }^{\circ} 29.00^{\prime}$ | 0 |
| 16.04.08 | 6* | 04:40 | E of Fehmarn and Fehmarnbelt | $54^{\circ} 20.02^{\prime}$ | 011*⒖97’ | 2 |
| 16.04.08 | 7 | 06:20 | E of Fehmarn and Fehmarnbelt | $54^{\circ} 19.80^{\prime}$ | 011 ${ }^{\circ} 16.00^{\prime}$ | 0 |
| 16.04.08 | 8 | 07:45 | E of Fehmarn and Fehmarnbelt | $54^{\circ} 21.80^{\prime}$ | 011 ${ }^{\circ} 23.20^{\prime}$ | 1 |
| 16.04.08 | 9 | 09:45 | E of Fehmarn and Fehmarnbelt | $54^{\circ} 28.60^{\prime}$ | 011²1.85' | 0 |
| 16.04.08 | 10 | 11:00 | E of Fehmarn and Fehmarnbelt | $54^{\circ} 26.00^{\prime}$ | 011 ${ }^{\circ} 24.50$ | 0 |
| 17.04.08 | 11 | 06:00 | SE Fehmarn and Bay of Lübeck | $54^{\circ} 19.20^{\prime}$ | 011 ${ }^{\circ} 21.50$ | 0 |
| 17.04.08 | 12 | 07:00 | SE Fehmarn and Bay of Lübeck | $54^{\circ} 17.50{ }^{\prime}$ | 011 ${ }^{\circ} 23.00^{\prime}$ | 0 |
| 17.04.08 | 13 | 08:15 | SE Fehmarn and Bay of Lübeck | $54^{\circ} 13.50{ }^{\prime}$ | 011 ${ }^{\circ} 21.50$ | 0 |
| 17.04.08 | 14 | 09:50 | SE Fehmarn and Bay of Lübeck | $54^{\circ} 16.80^{\prime}$ | 011 ${ }^{\circ} 17.20^{\prime}$ | 0 |
| 17.04.08 | 15 | 11:40 | SE Fehmarn and Bay of Lübeck | $54^{\circ} 19.25^{\prime}$ | 011 ${ }^{\circ} 16.10^{\prime}$ | 0 |
| 24.04.08 | 16 | 06:20 | Fehmarnbelt | $54^{\circ} 27.10^{\prime}$ | 011 ${ }^{\circ} 32.00$ | 0 |
| 24.04.08 | 17 | 07:40 | Fehmarnbelt | $54^{\circ} 26.70^{\prime}$ | 011 ${ }^{\circ} 28.20^{\prime}$ | 0 |
| 24.04.08 | 18 | 08:45 | Fehmarnbelt | $54^{\circ} 29.15^{\prime}$ | 011 ${ }^{\circ} 23.85$ ' | 0 |
| 24.04.08 | 19 | 09:55 | Fehmarnbelt | $54^{\circ} 30.30^{\prime}$ | 011 ${ }^{\circ} 20.30^{\prime}$ | 0 |
| 24.04.08 | 20 | 11:05 | Fehmarnbelt | $54^{\circ} 32.60^{\prime}$ | 011 ${ }^{\circ} 15.50$ ' | 0 |
| 25.04.08 | 21* | 03:15 | Bay of Lübeck | $54^{\circ} 12.00^{\prime}$ | 011 ${ }^{\circ} 17.80^{\prime}$ | 0 |
| 25.04.08 | 22* | 04:35 | Bay of Lübeck | $54^{\circ} 09.50$ | 011 ${ }^{\circ} 13.40^{\prime}$ | 0 |
| 25.04.08 | 23 | 05:50 | Bay of Lübeck | $54^{\circ} 11.80^{\prime}$ | 011 ${ }^{\circ} 15.50$ | 0 |
| 25.04.08 | 24 | 07:25 | Bay of Lübeck | $54^{\circ} 09.20^{\prime}$ | 011 ${ }^{\circ} 11.30$ | 0 |
| 25.04.08 | 25 | 08:55 | Bay of Lübeck | 54 ${ }^{\circ} 07.80$ | 011 ${ }^{\circ} 08.50$ | 0 |

Otoliths of young cod will be analysed to determine their age.

### 4.2.1 Effects of day/night fishery

Due to the experience of a survey with SAS 29 "Petra B." from Sassnitz (Rügen) some days before, it should be examined with this survey whether there is a day/night effect for fishery directed to cod recruits, which have to be considered for later investigations. In addition to regular survey stations, at station 8 southeast of Fehmarn one haul was conducted during night and afterwards another haul after dawn. During night 2 cod of 16.0 cm each were caught (total catch of cod: 13.8 kg ), whereby no cod $<20 \mathrm{~cm}$ was caught (total catch of cod: 18.3 kg ) (Tab.2, Fig.2). Two additional stations were sampled during day and night in the bay of Lübeck (stations 12 and 13), whereby no young cod < 20 cm was caught. Due to the very low numbers of small cod, a day/night effect could not be proven.

### 4.2.2 Comparison with other surveys: CRS (BUR 6 "Tümmler") vs. BITS (FRV "Solea")

Catch per unit effort of cod recruitment surveys was compared to the scientific BITS (Bottom International Trawl Survey) - data from journeys of FRV "Solea" from the years 2005 till 2008 ( $1^{\text {st }}$ Quarter in each case). In Fig. 2a) to 2e) the geographical distribution of the sampling stations and the number of caught $\operatorname{cod}<20 \mathrm{~cm}$ (standardised on 30 min hauls) are illustrated.

Two different trawls were used during CRS and BITS:

- BUR 6 "Tümmler": eel trawl (wing 40 mm mesh opening and codend 25 mm mesh opening)
- FRV "Solea": TV3-520 young fish trawl (lower wing 60 mm length of mesh size, $1^{\text {st }}$ continuous ring 40 mm length of mesh size and codend 10 mm length of mesh size)
Data from BITS surveys in $1^{\text {st }}$ quarter 2005-2008 show, that temporal and spatial variation of abundance of small cod exist. Especially during BITS in spring 2008, fewer small cod were found in ICES SD 22 compared to other years. These findings were proven by the CRS conducted with BUR 6 "Tümmler".


### 4.3 Hydrography

The hydrography data are not analysed so far.

### 4.4 Comparison to other research activities and outlook/perspective

JOIFISH/Lot8 - project partner from Denmark, Sweden and Germany have agreed to conduct a joint $2^{\text {nd }}$ CRS in autumn 2008 during a project meeting in June 2008 in Copenhagen. When planning a possible survey in autumn 2008 the following points have to be considered:

- international coordination (time, participating fishermen, sampling stations, fishing gear)
- station selection in accordance with statistic criteria (stratification, minimum distance)
- sampling of the range to 10 m water depth

Contrary to the original intention, it was difficult to sample areas shallower than 20 m - even with commercial fishing vessels. In spite of a special permission given by BLE and LALLF of Mecklenburg-Western Pomerania (legal entities responsible for fishing regulation), fishing within 3 nmi from shore and thus in depth zones $<20 \mathrm{~m}$ turns out difficult due to few experience with those fishing grounds and consequently high risk for gear and vessel.
Fishermen suggested sampling young cod with pound nets around Fehmarn as an alternative approach. Therefore, planning of a self-sampling scheme for this fishery to be conducted in autumn 2008 is in progress.
a)

b)

c)

d)

e)

Fig. 2): 2a) 537. cruise FRV "Solea", 10.02. - 26.02.2005; 2b) 553. cruise FRV "Solea", 16.02. 06.03.2006; 2c) 569. cruise FRV "Solea", 15.02. - 02.03.2007; 2d) 585. cruise (part b) FRV "Solea", 18.02. - 06.03.2008 und 2e) $1^{\text {st }}$ CRS with BUR 6 "Tümmler" 15.04.-17.04.08 and 24.04.25.04.08 (area around Fehmarn) and SAS 29 "Petra B." 07.04.-14.04.2008 (area around Rügen), distribution of young cod < 20 cm in the Western Baltic Sea; + means no young cod < 20 cm

## 5. Cooperation between Fishery and Fishery science

Skipper Gunnar Gerth-Hansen possesses extensive experiences with scientific projects (different surveys, wind park studies) and was open minded for scientific problems. Cooperation in planning and execution of the survey was uncomplicated. The crew was very communicative, flexible in work times and pleasantly
Unfortunately, it was not possible to catch small cod on those stations, which were selected by the skipper prior to the survey. Nevertheless, FRV "Solea" did not found small cod in this area (ICES SD 22) in spring 2008 as well. In addition, very strong easterly currents prevailed during the survey, which from the experience of the skipper represents bad conditions for the cod fishery.
Mr. Gerth-Hansen was also surprised by the small quantities of cod smaller than 38.0 cm , whereby the high number of Whiting was to be expected due to the bycatch in cod fishery (with BACOMA) in spring 2008.
Several weighing scales were used by the OSF: a steelyard balances (max. 15 kg and max 50 kg ) and a Marell balance ( 6 kg max.). Whereas the steelyard balances were provided by fishermen. The deck of BUR 6 "Tümmler" offers enough space for working and the sorting table is large and practical.
Mr. Gerth-Hansen personally provided a freezer to freeze samples of cod recruits. Topics like safe trawling stations, further possibilities of data acquisition and trawling equipment were discussed. Both Mr. Gerth-Hansen and the Institute for Baltic Sea Fishery are very much interested in a further close cooperation.

## 6. Acknowledgement

I thank Gunnar Gerth-Hansen and Andre Albrecht, as well as the scientific cruise participants Philipp Sayk and Kerstin Schuhmann for their very constructive and motivated work and the very good atmosphere on board.

Antje Krieger (chief scientist)

### 9.2 Cruise report for the ${ }^{\text {st }}$ CRS with SAS 29 "Petra B."

I nstitute for Baltic Fisheries

## Cruise report for the

$1^{\text {st }}$ Cod Recruitment Survey with fishing vessel SAS 29 "Petra B." from 07.04. till 10.04. and from 13.04. till 14.04.2008

Chief scientist: Antje Krieger

## 1. Background

The main problem with the current assessment of Baltic cod is the estimation of recruitment, especially of the age-groups 0 and 1 . Consequently, there are uncertainties about those agegroups which will be fished within the next years. Fishery requested solutions for this problem during the " $1^{\text {st }}$ Baltic Fisheries Dialogue" held in framework of the EU - Project JOYFISH/Lot8 in June 2007 and hosted by the Institute for Baltic Fisheries in Rostock. Hereby cooperation between fishery and fishery science was recommended.
Fishermen reported that the juvenile cod could be found very close to the shore in water shallower than 20 meters primarily during spring.
Frequently, fishermen and fishermen's organisation criticise the choice of wrong sampling time, wrong fishing gear and wrong sampling area (e.g. no coverage of areas shallower than 20 m ) for scientific surveys. On the other hand, it makes no sense to change periodical scientific surveys like the Baltic International Trawl Surveys (BITS) for a lot of reasons. The main reason is that the goal of such surveys is to establish long time series to identify changes in the ecosystem and fish stocks. Those time series need standardised methods, which are kept stable for long periods and which are coordinated internationally. Furthermore there are limitations in available ship time, as well as hauling positions in shallower water. Consequently, the idea was born to establish a joint survey on board of a commercial fishing vessel. The $1^{\text {st }}$ Cod Recruitment Survey (CRS) started in April 2008 with two German commercial fishing vessels:
3. BUR 6 "Tümmler" in ICES SD 22 in the area around Fehmarn
4. SAS 29 "Petra B." in ICES SD 24 in the area around Rügen

Both surveys were carried out as feasibility studies as part of the EU-project JOIFISH/Lot8. They were characterised by:

- The skipper of the fishing vessel has selected sampling stations prior to the survey, whereby stations should be optimal to catch young cod. Thereby the experience of the fishermen is of great importance. This station selection could be used for later surveys as well. Thus a meaningful data acquisition of the cod stock for a long time period would be possible and maybe it allows documenting year to year changes. The aim of that survey was to evaluate and check the possibility for such a survey on a commercial fishing vessel in order to get information about the year class strength of Baltic cod. On a long-term basis such data could be used as additional index for assessment of Western Baltic cod stock.
- The fishing gear suitable to catch cod recruits was selected and delivered by participating fishermen. Regarding a possible establishment of a time series it is necessary to use the same fishing gear also in the subsequent years.
- The investigation period was coordinated with the fishermen. Thus the fishermen experiences were of great importance.
The catches were analysed on board by scientific staff. Planning and data evaluation was conducted in cooperation with participating fishermen. They were also informed about the results. Furthermore, an optimization of following surveys will be discussed.


## 2. Tasks of the survey

- test of joint surveys between fishery and fishery science on board of commercial fishing vessels
- sampling of data about the growth habitats and biological characteristics of cod recruits in the western Baltic Sea
- sampling of hydrographical data (temperature, oxygen content, salinity)


## 3. Cruise activities

One part of the $1^{\text {st }}$ CRS in April 2008 was conducted with fishing vessel SAS 29 "Petra B." (stern trawler, 11.83 m , forward draught 1.40 m and aft draught $2.50 \mathrm{~m}, 1500 \mathrm{RT}$, made of GRP, year of construction: 1999, crew: 2 men). During the survey a Danish eel trawl ( 40 mm mesh opening in the wing, 25 mm mesh opening in the cod end) was used. In the 4 sampling areas (Fig.1, Tab.1) 20 hauls were conducted with a duration of 30 min each. With a CTD probe (CTP 004 sensor from Sea and Sun Technologies) hydrographic measurements took place on 19 of 20 stations directly after heaving.
07.04: setting up SAS 29 "Petra B." and fishing in the area Lehmberge (circa 20 nmi north of Sassnitz, 5 hauls, circulating wind, $0-1$ bft, $1 / 8$ till $3 / 8$ cloudiness, $4-10{ }^{\circ} \mathrm{C}$ air temperature
08.04: stayed in harbour because of heavy wind, $6-7 \mathrm{bft}$
09.04: fishing 15-20 nmi east of Rügen, 5 hauls, circulating as well as NW and SW wind, 1-3 bft, $2 / 8$ till $4 / 8$ cloudiness, $5-8^{\circ} \mathrm{C}$ air temperature
10.04: fishing in the area Tromper Wiek, on the $3^{\text {rd }}$ haul 1 groyne stack and 1 fyke stack into the net and on the $4^{\text {th }}$ haul a net damage because of an underwater barrier, NE and SE wind, 2 bft, $2 / 8$ till $3 / 8$ cloudiness, $4-6{ }^{\circ} \mathrm{C}$ air temperature
11.04.-13.04 reparation of the Danish eel trawl
13.04: fishing in the area Sassnitzer Graben, 3 hauls at day and night each, circulating wind, $2 / 8$ till $5 / 8$ cloudiness at day and partially rain at night, $5-12^{\circ} \mathrm{C}$ air temperature
14.04: back at Sassnitz harbour at 01:00 am and cleaning SAS 29 "Petra B." in the morning


Fig. 1: Scheme of sampling stations (1.Lehmberge, 2.east of Rügen, 3. Tromper Wiek, 4. Sassnitzer Graben).

Scheme of sampling stations (1.Lehmberge, 2.east of Rügen, 3. Tromper Wiek, 4. Sassnitzer Graben).

## 4. Results

### 4.1 Fishery

During the survey altogether 2595 kg fish were caught with 25 hauls of 30 min in each case (Tab. 1.). Thereby cod with 1186 kg represented the largest proportion. With 605 kg flounder formed the second strongest proportion and nearly all about the same were the herring/sprat mix (153 kg), plaice $(145 \mathrm{~kg})$ and whiting ( 130 kg ).

Tab. 1: Catch composition of 20 hauls divided for sampling areas

| Date | Sampling area | Cod | Herring <br> /Sprat <br> $(\mathrm{kg})$ | Whiting <br> $(\mathrm{kg})$ | Dab |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $(\mathrm{kg})$ | Flounder |  |  |  |  |  |  |  |  |  |
| $(\mathrm{kg})$ | Plaice | Turbot | Rest | Total <br> catch |  |  |  |  |  |  |
| $(\mathrm{kg})$ | $(\mathrm{kg})$ | $(\mathrm{kg})$ | $(\mathrm{kg})$ |  |  |  |  |  |  |  |
| 07.04 .08 | Lehmberge | 1077,30 | 116,60 | 130,50 | 7,20 | 352,30 | 22,80 | 0,30 | 0,85 | 1707,85 |
| 09.04 .08 | east of Rügen | 201,40 | 9,60 | 0,00 | 1,45 | 20,05 | 80,60 | 15,95 | 0,16 | 329,22 |
| 10.04 .08 | Tromper Wiek | 56,80 | 0,00 | 0,00 | 9,90 | 38,10 | 26,00 | 9,80 | 0,75 | 141,35 |
| 13.04 .08 | Sassnitzer <br> Graben | 140,70 | 27,07 | 0,35 | 21,60 | 195,00 | 16,05 | $\mathbf{1 1 , 8 0}$ | 15,28 | 427,85 |
|  | Total | $\mathbf{1 4 7 6 , 2 0}$ | $\mathbf{1 5 3 , 2 7}$ | $\mathbf{1 3 0 , 8 5}$ | $\mathbf{4 0 , 1 5}$ | $\mathbf{6 0 5 , 4 5}$ | $\mathbf{1 4 5 , 4 5}$ | $\mathbf{3 7 , 8 5}$ | $\mathbf{1 7 , 0 4}$ | $\mathbf{2 6 0 6 , 2 6}$ |

### 4.2 Cod recruits

On 20 sampling stations around Rügen altogether 717 young cods $<20 \mathrm{~cm}$ were caught (Tab.2, Fig. 2e). The following distribution resulted from the separate sub regions: 118 pieces Lehmberge, 11 pieces east of Rügen, 3 pieces Tromper Wiek and 582 pieces Sassnitzer Graben (Tab.2, Fig. 4 e). (* night fishery)

Tab. 2: Location of sampling stations and number of young cods $<\mathbf{2 0} \mathbf{~ c m}$. (* night fishery)

| Date | Haul | Time (hh:mm) | Sampling area | Latitude ( ${ }^{\circ} \mathrm{N}$ ) | Longitude | Number of cod (<20 cm) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 07.04.08 | 1 | 10:55 | Lehmberge | $54^{\circ} 46.76$ | $013^{\circ} 46.21^{\prime}$ | 48 |
| 07.04.08 | 2 | 12:10 | Lehmberge | 54²9.98' | 013 ${ }^{\circ} 42.61^{\prime}$ | 21 |
| 07.04.08 | 3 | 13:55 | Lehmberge | $54^{\circ} 52.31{ }^{\prime}$ | 013 ${ }^{\circ} 38.78{ }^{\prime}$ | 26 |
| 07.04.08 | 4 | 15:40 | Lehmberge | $54^{\circ} 53.71{ }^{\prime}$ | $013^{\circ} 32.21{ }^{\prime}$ | 13 |
| 07.04.08 | 5 | 17:13 | Lehmberge | $54^{\circ} 51.79^{\prime}$ | 013 ${ }^{\circ} 26.71{ }^{\prime}$ | 13 |
| 09.04.08 | 6 | 07:52 | east of Rügen | $54^{\circ} 34.19^{\prime}$ | 013 ${ }^{\circ} 55.38{ }^{\prime}$ | 1 |
| 09.04.08 | 7 | 08:53 | east of Rügen | $54^{\circ} 32.65{ }^{\prime}$ | 013 ${ }^{\circ} 58.78{ }^{\prime}$ | 2 |
| 09.04.08 | 8 | 10:28 | east of Rügen | $54^{\circ} 38.55{ }^{\prime}$ | 014 ${ }^{\circ} 04.89^{\prime}$ | 4 |
| 09.04.08 | 9 | 11:35 | east of Rügen | $54^{\circ} 41.38^{\prime}$ | 014 ${ }^{\circ} 05.16$ | 2 |
| 09.04.08 | 10 | 12:50 | east of Rügen | $54^{\circ} 42.24^{\prime}$ | 014 ${ }^{\circ} 07.59^{\prime}$ | 2 |
| 10.04.08 | 11 | 08:09 | Tromper Wiek | $54^{\circ} 39.95{ }^{\prime}$ | 013 ${ }^{\circ} 32.27{ }^{\prime}$ | 1 |
| 10.04.08 | 12 | 09:30 | Tromper Wiek | $54^{\circ} 37.75{ }^{\prime}$ | 013 ${ }^{\circ} 27.46$ ' | 2 |
| 10.04.08 | 13 | 10:40 | Tromper Wiek | $54^{\circ} 37.05{ }^{\prime}$ | 013 ${ }^{\circ} 23.60$ ' | 0 |
| 13.04.08 | 15 | 16:08 | Sassnitzer Graben | $54^{\circ} 31.12^{\prime}$ | 013 ${ }^{\circ} 43.58{ }^{\prime}$ | 24 |
| 13.04.08 | 16 | 17:30 | Sassnitzer Graben | $54^{\circ} 29.07{ }^{\prime}$ | 013 ${ }^{\circ} 42.84{ }^{\prime}$ | 54 |
| 13.04.08 | 17 | 18:45 | Sassnitzer Graben | $54^{\circ} 25.75{ }^{\prime}$ | 013 ${ }^{\circ} 46.17{ }^{\prime}$ | 22 |
| 13.04.08 | 18* | 21:05 | Sassnitzer Graben | $54^{\circ} 24.81^{\prime}$ | 013 ${ }^{\circ} 45.72^{\prime}$ | 192 |
| 13.04.08 | 19* | 22:10 | Sassnitzer Graben | $54^{\circ} 27.81{ }^{\prime}$ | 013 ${ }^{\circ} 43.98{ }^{\prime}$ | 210 |
| 13.04.08 | 20* | 23:20 | Sassnitzer Graben | $54^{\circ} 31.39^{\prime}$ | 013 ${ }^{\circ} 44.36{ }^{\prime}$ | 80 |

The length frequency distribution of cod < 20 cm clarifies that in April 2008 in the sea-areas north and east of Rügen cod occurred in the length classes from 5.0 to 19.5 cm . In the range of the area Lehmberge the length class spectrum was altogether more inhomogeneous as within in the range of the area Sassnitzer Graben. Thereby formed the length classes of $10.0 \mathrm{~cm}-11.5 \mathrm{~cm}$ the largest portion group under all cods $<20 \mathrm{~cm}$ fished there (Fig. 2). Otoliths of young cod will be analysed to determine their age.


Fig. 2: Length frequency distribution of small cods $<20 \mathrm{~cm}$ in the area of Lehmberge (07.04.08) and in the area of Sassnitzer Graben (13.04.08)

### 4.2.1 Effects of day/night fishery

Because the recruit fishery did not succeeded in such a way during the day as accepted by the crew before both in the Tromper Wiek and east of Rügen, the skippers proposal was to try out fishery also in the night. This was accomplished also in the context of the optimization of the pilot survey. Therefore at 13.04.08 in the Sassnitzer Graben were completed 3 hauls at day and 3 at night each. There are indices on a day/night effect, as during the day 100 pieces and during the night 482 pieces cod $<20 \mathrm{~cm}$ were caught (Tab. 2).
The comparison of the relative frequency distributions of cod $<20 \mathrm{~cm}$ between day and night hauls in the Sassnitzer Graben shows that by day above all cod in lengths of 10.0 cm dominated, followed from $5.0-7.0 \mathrm{~cm}$ and 8.5 cm catches. During the night cod recruits were characterised particularly by the length classes from 9.0 cm to 12.5 cm (Fig. 3).


Fig.3: Length frequency distribution of small cods $<\mathbf{2 0} \mathbf{~ c m}$ at different time of day (Sassnitzer Graben)

### 4.2.2 Comparison with other surveys: CRS (SAS 29 "Petra B.") vs. BITS (FFS "Solea")

Catch per unit effort of cod recruitment surveys was compared to the scientific BITS (Bottom International Trawl Survey) - data from journeys of FRV "Solea" from the years 2005 till 2008 ( $1^{\text {st }}$ Quarter in each case). The geographical distribution of the sampling stations and thereby the number of caught cods $<20 \mathrm{~cm}$ (standardised on 30 minutes hauls) are illustrated in figure 4a) to 4e)
a)

b)

c)

d)


Fig. 4 a) till 4e): 4a) 537. Journey FFS "Solea", 10.02. - 26.02.2005; 4b) 553. Journey FFS "Solea", 16.02. - 06.03.2006; 4c) 569. Journey FFS "Solea", 15.02. - 02.03.2007; 4d) 585. Journey part b FFS "Solea", 18.02. - 06.03.2008 und 4e) $1^{\text {st }}$ CRS, BUR 6 "Tümmler" 15.04.17.04.08 and 24.04.-25.04.08 (area around Fehmarn) and SAS 29 "Petra B." 07.04.-14.04.2008 (area around Rügen): distribution of young cod $<20 \mathrm{~cm}$ inside of the sampling area of the Western Baltic; + means no cod recruits < 20 cm

Two different trawls were used during CRS and BITS:

- BUR 6 "Tümmler": eel trawl (wing 40 mm mesh opening and cod end 25 mm mesh opening)
- FRV "Solea": TV3-520 young fish trawl (lower wing 60 mm length of mesh size, $1^{\text {st }}$ continuous ring 40 mm length of mesh size and cod end 10 mm length of mesh size)
Data from BITS surveys in $1^{\text {st }}$ quarter 2005-2008 show, that temporal and spatial variation of abundance of small cod exist. Especially during BITS in spring 2008, fewer small cod were found in ICES SD 22 compared to other years. These findings were proven by the CRS conducted with BUR 6 "Tümmler".


### 4.3 Hydrography

The hydrography data are not analysed so far.

### 4.4 Comparison to other research activities and outlook/perspective

JOIFISH/Lot8 - project partner from Denmark, Sweden and Germany have agreed to conduct a joint $2^{\text {nd }}$ CRS in autumn 2008 during a project meeting in June 2008 in Copenhagen. When planning a possible survey in autumn 2008 the following points have to be considered:

- international coordination (time, participating fishermen, sampling stations, fishing gear)
- station selection in accordance with statistic criteria (stratification, minimum distance)
- sampling of the range to 10 m water depth

Contrary to the original intention, it was difficult to sample areas shallower than 20 m - even with commercial fishing vessels. In spite of a special permission given by BLE and LALLF of Mecklenburg-Western Pomerania (legal entities responsible for fishing regulation), fishing within 3 nmi from shore and thus in depth zones < 20 m turns out difficult due to few experience with those fishing grounds and consequently high risk for gear and vessel.
Fishermen suggested sampling young cod with pound nets around Fehmarn as an alternative approach. Therefore, planning of a self-sampling scheme for this fishery to be conducted in autumn 2008 is in progress.

## 5. Cooperation between fishery and fishery science

Skipper Breese possesses extensive experiences with scientific projects (different surveys, wind park - and Gazprom studies) and was open minded for scientific problems. Cooperation in planning and execution of the survey was uncomplicated. The crew was very communicative, flexibly in work times and pleasantly. Mr. Breese even drilled holes into vessels side in order to fasten a board that the steel cable of the CTD could run easy into the water. Mr. Breese was characterised by very high readiness during the survey.
The experience of the skipper was reflected in successful selected sampling areas for sampling cod recruits. He also suggested the night fishery. Despite the net damage the survey continued after a 3 days repair.
Several weighing scales were used: an electronic balance from the company Kern and a Danish fish balance for 30 kg boxes. The balances were provided by fishermen and both worked well under field conditions on board. The OSF procured similar balances for commercial sampling. Topics like safe trawling stations, further possibilities of data acquisition and trawling equipment were discussed and are considered in subsequent projects. Both Mr. Breese and the Institute for Baltic Fisheries are very much interested in a further close cooperation.

## 6. Acknowledgement

I thank Uwe Breese and Matthias Lucas, as well as the scientific cruise participant Philipp Sayk for their very constructive and motivated work and the very good atmosphere on board. I also thank the "Kutter- und Küstenfisch GmbH" for the possibility for cooling samples in Sassnitz during the survey.

### 9.3 Cruise report for the $2^{\text {nd }}$ CRS with SAS 29 "Petra B."

## I nstitute of Baltic Sea Fisheries

# Cruise report for the <br> $2^{\text {nd }}$ Cod Recruitment Survey with fishing vessel SAS 29 "Petra B." from 04.11. till 30.11.2008 

Chief scientist: Ronny Weigelt

## 1. Background

During a project meeting in June 2008 in Copenhagen/Denmark and the $2^{\text {nd }}$ BFD in October 2008 in Karlskrona/Sweden, JOIFISH/Lot8 - project partner from Denmark, Sweden and Germany have agreed to conduct a joint $2^{\text {nd }}$ CRS in November 2008. The survey was scheduled for November 2008 in order to have the possibility to compare the results of the national CRS with the results derived from the Baltic International Trawl Survey Q4, which is conducted in the same month. Finally, Denmark was not able to conduct the survey due to logistical reasons (missing man power)

After analysing the data from the spring survey, the following points had to be considered for the survey in autumn:

- international coordination (time, participating fishermen, sampling stations, fishing gear)
- station selection in accordance with statistic criteria (stratification, minimum distance) would be beneficial
- sampling in shallow waters of 10 m water depth
- the German survey should be conducted with the same fishing vessels as in spring


## 2. Tasks of the survey

The tasks of the $2^{\text {nd }}$ CRS were very similar to the first one in spring 2008. Main aim of the survey was to test the feasibility of a joint survey between fishery and fishery science on board of commercial fishing vessels targeting 0 -group cod. Another aim was to investigate nursery grounds and biological characteristics of cod recruits in the western Baltic Sea.

## 3. Cruise activities

As in spring, it was planned to conduct the survey with two vessels (SAS29 and BUR6). Due to very bad weather condition in November 2008, the survey was conducted solely SAS 29
"Petra B." exclusively (stern trawler, 11.83 m , forward draught 1.40 m and aft draught 2.50 m , 1500 RT, made of GRP, year of construction 1999, 2 men crew).
Bad weather conditions restricted sampling to four days at sea in the period from $4^{\text {th }}$ to $30^{\text {th }}$ November 2008.
During the survey a Danish eel trawl ( 40 mm mesh opening in the wing, 25 mm mesh opening in the cod end) was used. In the 4 sampling areas (Fig.1, Tab.1) 18 hauls were conducted with a duration of 30 min each. Because of technical complications, no hydrographical measurements were conducted.

## Timetable

04.11.: setting up SAS 29 "Petra B." and fishing in the area Lehmberge (circa 20 nmi north of Sassnitz, 5 hauls, NE wind, $2-3$ bft, $8 / 8$ cloudiness, $7^{\circ} \mathrm{C}$ air temperature
13.11.: fishing in the area Sassnitzer Graben and Tromper Wiek, 5 hauls, $W$ wind, $4-5$ bft, 1/8 till $6 / 8$ cloudiness, $7^{\circ} \mathrm{C}$ air temperature
17.11.: fishing in the area Sassnitzer Graben, 5 hauls, W wind, 3 bft, $3 / 8$ till $6 / 8$ cloudiness, $4^{\circ}$ C air temperature
30.11.: fishing $5-10$ nmi east of Rügen, 3 hauls, circulating as well as S-SO wind, 3 bft, $7 / 8$ till $8 / 8$ cloudiness, $2^{\circ} \mathrm{C}$ air temperature


Fig.1: Scheme of sampling stations (areas: 1.Lehmberge, 2. Tromper Wiek, 3. and 4. Sassnitzer Graben

## 4. Results

### 4.1 Fishery

During the survey with 18 hauls of 30 min each altogether 2460 kg fish were caught. Thereby the flatfishes with 1500 kg represented the largest fraction. 612 kg cod and 285 kg whiting was caught. Herring/sprat ( 29 kg ) and eel ( 26 kg ) catches were very low (see at Tab. 1).

Tab.1: Catch composition of 18 hauls at four sampling areas

| Date | Sampling <br> area | Cod |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $(\mathrm{kg})$ | Herring/ <br> Sprat <br> $(\mathrm{kg})$ | Whiting <br> $(\mathrm{kg})$ | Flatfish | Eel | (kg) | $(\mathrm{kg})$ | $(\mathrm{kg})$ | $(\mathrm{kg})$ |
| 04.11 .08 | Lehmberge | 211.3 | 7.4 | 116.0 | 268.4 | 13.1 | 3.8 | 620.0 |
| 13.11 .08 | Tromper Wiek | 313.6 | 18.15 | 166.0 | 1017.2 | 13.27 | 2.3 | 1530.5 |
| $13 . / 17 . / 30.11 .08$ | Sassnitzer <br> Graben | 87.2 | 3.8 | 3.6 | 215 | 0.0 | 0.0 | 310 |
|  | Total | $\mathbf{6 1 2 . 1}$ | $\mathbf{2 9 . 3}$ | $\mathbf{2 8 5 . 6}$ | $\mathbf{1 5 0 0 . 6}$ | $\mathbf{2 6 . 4}$ | $\mathbf{6 . 5}$ | $\mathbf{2 4 6 0 . 5}$ |

### 4.2 Cod recruits

At 18 stations around Rügen altogether 548 cod recruits < 20 cm were caught (Tab.2, Fig. 4). The following numbers were found at the four sampling areas: 232 specimen Lehmberge, 217 specimen Sassnitzer Graben, 99 specimen Tromper Wiek (Tab.2, Fig. 4).

Tab. 2: Location of sampling stations and number of cod recruits $<20 \mathrm{~cm}$.

| Haul | Date | Sampling area | Time (hh:mm) | Latitude $\left({ }^{\circ} \quad \mathrm{N}\right)$ | Longitude ( ${ }^{\circ}$ 'E) | Number of cod ( $<20 \mathrm{~cm}$ ) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1 | 04.11.2008 | Lehmberge | 09:35 | $54^{\circ} 44.661^{\prime}$ | $13^{\circ} 30.089^{\text {¢ }}$ | 72 |
| 2 | 04.11.2008 | Lehmberge | 10:55 | 54* $48.726^{\prime}$ | $13^{\circ} 25.019^{\prime}$ | 23 |
| 3 | 04.11.2008 | Lehmberge | 12:10 | $54^{\circ} 51.979$ | $13^{\circ} 28.906{ }^{\prime}$ | 31 |
| 4 | 04.11.2008 | Lehmberge | 13:25 | 54* $52.230{ }^{\text {c }}$ | $13^{\circ} 35.749^{\prime}$ | 51 |
| 5 | 04.11.2008 | Lehmberge | 14:30 | $54^{\circ} 50.484^{\prime}$ | $13^{\circ} 41.351^{\prime}$ | 55 |
| 6 | 13.11.2008 | Sassnitzer Graben | 09:15 | $54^{\circ} 30.949{ }^{\text {، }}$ | 1343.396 ${ }^{\circ}$ | 23 |
| 7 | 13.11.2008 | Sassnitzer Graben | 10:06 | $54^{\circ} 32.201^{\prime}$ | $13^{\circ} 43.047$ | 21 |
| 8 | 13.11.2008 | Tromper Wiek | 11:30 | 54*37.539 ${ }^{\circ}$ | $13^{\circ} 41.583^{\prime}$ | 57 |
| 9 | 13.11.2008 | Tromper Wiek | 13:00 | 54*39.405 | $13^{\circ} 37.671^{\prime}$ | 24 |
| 10 | 13.11.2008 | Tromper Wiek | 13:45 | $54^{\circ} 41.014^{\prime}$ | $13^{\circ} 30.274^{\prime}$ | 18 |
| 11 | 17.11.2008 | Sassnitzer Graben | 11:10 | $54^{\circ} 32.823{ }^{\prime}$ | $13^{\circ} 44.629{ }^{\circ}$ | 59 |
| 12 | 17.11.2008 | Sassnitzer Graben | 12:15 | $54^{\circ} 29.265^{\text {' }}$ | $13^{\circ} 43.75{ }^{\text {¢ }}$ | 9 |
| 13 | 17.11.2008 | Sassnitzer Graben | 13:10 | $54^{\circ} 26.998{ }^{\prime}$ | $13^{\circ} 44.629^{\prime}$ | 13 |
| 14 | 17.11.2008 | Sassnitzer Graben | 14:00 | $54^{\circ} 24.766{ }^{\prime}$ | $13^{\circ} 46.104{ }^{\circ}$ | 17 |
| 15 | 17.11.2008 | Sassnitzer Graben | 15:05 | $54^{\circ} 25.245^{\prime}$ | $13^{\circ} 44.778^{\prime}$ | 7 |
| 16 | 30.11.2008 | Sassnitzer Graben | 10:00 | $54^{\circ} 28.246{ }^{\prime}$ | $13^{\circ} 46.647{ }^{\text {¢ }}$ | 27 |
| 17 | 30.11.2008 | Sassnitzer Graben | 10:40 | $54^{\circ} 28.524^{\prime}$ | $13^{\circ} 51.244^{\prime}$ | 21 |
| 18 | 30.11.2008 | Sassnitzer Graben | 11:15 | $54^{\circ} 30.459$ | $13^{\circ} 53.380{ }^{\text {c }}$ | 20 |



Fig. 2: Fraction of cod < 20 cm in November 2008


Fig. 3: Length frequency distribution of cod recruits < 20 cm caught with SAS 29 in November
Comparison with Baltic International Trawl Survey with FRV "Solea" (BITS Q4)
The catch per unit effort of cod recruitment surveys was compared to the scientific BITS (Bottom International Trawl Survey) - data from journeys of FRV "Solea" from the years 2005 till 2008 ( $1^{\text {st }}$ Quarter in each case). The geographical distribution of the sampling stations and thereby the number of caught cods $<20 \mathrm{~cm}$ (standardised on 30 minutes hauls) are illustrated in figure 4.

BITS data from 2005-2008 show, that exist temporal and spatial variation of abundance of cod recruits. Especially during BITS in spring 2008 fewer cod recruits were found in ICES SD 22 compared to other years. These findings were proven by the CRS conducted with BUR 6 "Tümmler".

Similar spatial patterns were found in both surveys in April. The BITS, as well as the CRS did not found significant numbers of small cod in ICES SD22 (around Fehmarn), but found relative large numbers in SD 24 (around Rügen).

Nevertheless, the direct comparison between scientific BITS and CRS is not possible, since the CPUE depends on several parameters, which differ between vessels and surveys. For instance, two different trawls were used during CRS and BITS:

- CRS: Eel trawl (wing 40 mm mesh opening, codend 25 mm mesh opening)
- BITS: TV3-520 young fish trawl (lower wing 60 mm length of mesh size, 1st continuous ring 40 mm length of mesh size, codend 10 mm length of mesh size)

Nevertheless, the (long-term) aim of the CRS was to test whether it is possible to establish a time series index for the abundance of 0 -group cod in the western Baltic. Therefore, a meaningful comparison would include a comparison of the performance of a recruitment index derived from both approaches. Additionally, as said above, the poor recruitment estimate of recent surveys was the key to test other approaches. Therefore, a comparison with this "poor" index would be meaningless. Moreover, the performance of a new index has to be evaluated in the assessment. It is not possible to follow both approaches, since no time series is available for the CRS.


Fig. 4: Catch per Unit Effort (30min) of cod < 20 cm from Baltic International Trawl Survey (BITS) and Cod recruitment Survey (CRS). The year and season is given in every plot. Left column: BITS 1st quarter and CRS April 2008; Right column: BITS 4th quarter and CRS November 2008

Data from BITS surveys 2005-2008 show, that temporal and spatial variation of abundance of small cod exist. Especially during BITS in spring 2008, fewer small cod were found in ICES SD 22 compared to other years. These findings were proven by the CRS conducted with BUR 6 "Tümmler".

### 4.3 Hydrography

No hydrographical measurement took place because of technical problems and unsuitable weather conditions.

### 4.4 Comparison to other research activities and outlook/perspective

Contrary to the original intention, it was difficult to sample areas shallower than 20 m - even with commercial fishing vessels. In spite of a special permission given by BLE and LALLF of Mecklenburg-Western Pomerania (legal entities responsible for fishing regulation), fishing within 3 nmi from shore and thus in depth zones $<20 \mathrm{~m}$ turns out difficult due to few experience with those fishing grounds and consequently high risk for gear and vessel.

## 5. Cooperation between fishery and fishery science

Skipper Breese possesses extensive experiences with scientific projects (different scientific surveys like wind park and Gazprom studies) and was open minded for scientific problems. Cooperation in planning and execution of the survey was uncomplicated. The crew was very communicative, flexibly in work times and pleasantly. Mr. Breese was characterised by very high readiness during the survey.
The experience of the skipper was reflected in successful selected sampling areas for sampling cod recruits.
Several weighing scales were used: an electronic balance from the company Kern and a Danish fish balance for 30 kg boxes. The balances were provided by fishermen and both worked well under field conditions on board. Topics like safe trawling stations, further possibilities of data acquisition and trawling equipment were discussed and are considered in subsequent projects. Both Mr. Breese and the Institute of Baltic Sea Fisheries are very much interested in a further close cooperation.

## 6. Acknowledgement

I thank Uwe Breese and his trainee, as well as the scientific cruise participant Petra Jantschik for their motivated work on board and the very relaxed atmosphere.

### 9.4 Cruise report for the $2^{\text {nd }}$ CRS with SIN 18 "Vingarö"

Cruise report for the JOIFISH/Lot8<br>Swedish Cod Recruitment Survey with fishing boat SIN 18<br>"Vingarö"<br>November 2009

## 1. Background

The main problem with the current assessment of Baltic cod is the estimation of recruitment, especially of the age-groups 0 and 1 . Consequently, there are uncertainties about those agegroups which will be fished within the next years. Fishery requested solutions for this problem during the " 1 st Baltic Fisheries Dialogue" held in framework of the EU - Project JOIFISH/Lot8 in June 2007 and hosted by the Institute for Baltic Fisheries in Rostock. Hereby cooperation between fishery and fishery science was recommended.
Frequently, fishermen and fishermen's organization criticise the choice of wrong sampling time, wrong fishing gear and wrong sampling area (e.g. no coverage of areas shallower than 20 m ) for scientific surveys. On the other hand, it makes no sense to change periodical scientific surveys like the Baltic International Trawl Surveys (BITS) for a lot of reasons. The main reason is that the goal of such surveys is to establish long time series to identify changes in the ecosystem and fish stocks. Those time series need standardised methods, which are kept stable for long periods and which are coordinated internationally. Furthermore there are limitations in available ship time, as well as hauling positions in shallower water.
Consequently, the idea was born to establish a joint survey onboard a commercial fishing vessel.
The $1^{\text {st }}$ Cod Recruitment Survey (CRS) started in 2008 with two German and one Swedish commercial fishery vessels:
5. BUR 6 "Tümmler" in ICES SD 22 in the area around Fehmarn
6. SAS 29 "Petra B." in ICES SD 24 in the area around Rügen
7. SIN 18 "Vingarö" in ICES SD 25 in the area around Simrishamn.

All surveys were carried out as feasibility studies as part of the EU-project JOIFISH/Lot8. They were characterised by:

- The skipper of the fishing vessel has selected sampling stations prior to the survey, whereby stations should be optimal to catch young cod. Thereby the experience of the fishermen is of great importance. This station selection could be used for later surveys as well. Thus a meaningful data acquisition of the cod stock for a long time period would be possible and maybe it allows documenting year to year changes. The aim of that survey was to evaluate and check the possibility for such a survey on a commercial fishing vessel in order to get information about the year class strength of Baltic cod. On a long-term basis such data could be used as additional index for assessment of the Eastern and Western Baltic cod stocks.
- The fishing gear suitable to catch cod recruits was selected and delivered by participating fishermen. Regarding a possible establishment of a time series it is necessary to use the same fishing gear also in the subsequent years.
- The investigation period was coordinated with the fishermen. Thus the fishermen experiences were of great importance.
- The Swedish survey took place in SD 25 . The original outline for JOIFISH/Lot8 was to investigate the Western Baltic Cod Stock (SD22-24). Although the reference
fisherman did not recommend this area for the Swedish part of the investigation. It was accepted by the Scientist in JOIFISH/Lot8 to go ahead with the recommendations of the reference fisherman. It was also best connected with the BITS survey performed by Swedish research vessel "Argos" in the same time period.

The catches were analysed on board by scientific staff. Planning was conducted in cooperation with participating fishermen. They were also informed about the results. Furthermore, an optimization of following surveys will be discussed.

This is the report of the Swedish CRS onboard SIN 18 "Vingaro". The German CRS are reported in separate documents.

## 2. Cruise activities

The Swedish CRS was conducted with fishery boat SIN 18 "Vingarö." (stern trawler, 11.51 m, 39 GRT, engine 175 kW ). During the survey a cod trawl combined with a herring cod end (40 mm mesh opening in the wing, 16 mm mesh opening in the cod end) was used. The survey was conducted in Sub Division 25 outside Simrishamn (Fig.1, Tab.1). 21 hauls were conducted with a duration of 30 min each.
Due to weather conditions the survey was performed in two time periods 17-20 November (no fishing 18 November due to strong winds) and 26-27 November 2009.


Fig. 1: Sampling stations. Black symbols are R/V Argos BITS cruise 17-28 nov 2008. White symbols are SIN 18 Vingarö stations for 17-20 nov and 26-27 nov.

## 3. Results

During the survey altogether 1196 kg fish were caught with 21 hauls, 30 min each (Tab. 1.). Cod represented the largest portion with 1115 kg followed by plaice, flounder and turbot.

Tab. 1: Catch composition of 21 hauls for sampling area.

| Date | Sampling area <br> SD | Cod | Flounder | Plaice | Turbot | Total catch |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $(\mathrm{kg})$ | $(\mathrm{kg})$ | $(\mathrm{kg})$ | $(\mathrm{kg})$ | $(\mathrm{kg})$ |  |  |
| 20081117 | 25 | 210 |  | 40 | 4 | 254 |
| 20081119 | 25 | 160 | 2 | 3 | 2 | 167 |
| 20081120 | 25 | 370 | 11 | 1 | 1 | 383 |
| 20081126 | 25 | 235 | 5 |  | 5 | 245 |
| 20081127 | 25 | 140 | 4 |  | 3 | 147 |
|  | Total | $\mathbf{1 1 1 5}$ | $\mathbf{2 2}$ | $\mathbf{4 4}$ | $\mathbf{1 5}$ | $\mathbf{1 1 9 6}$ |

On 21 sampling stations around Simrishamn altogether 84 young cods $<20 \mathrm{~cm}$ were caught (Tab.2, Fig. 2)

Tab. 2: Location of sampling stations and number of young cod $<\mathbf{2 0} \mathbf{~ c m . ~}$

| Date | Haul | Sampling area SD | Latitude ( ${ }^{\circ}$ 'N) | Longitude | Number of cod (<20 cm) |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 081117 | 1 | 25 | $55^{\circ} 27^{\prime}$ | $14^{\circ} 27^{\prime}$ | 9 |
| 081117 | 2 | 25 | $55^{\circ} 28^{\prime}$ | $14^{\circ} 21^{\prime}$ | 1 |
| 081117 | 3 | 25 | $55^{\circ} 27^{\prime}$ | $14^{\circ} 28^{\prime}$ | 9 |
| 081117 | 4 | 25 | $55^{\circ} 26^{\prime}$ | $14^{\circ} 32^{\prime}$ | 6 |
| 081117 | 5 | 25 | $55^{\circ} 27^{\prime}$ | $14^{\circ} 28^{\prime}$ | 6 |
| 081119 | 6 | 25 | $55^{\circ} 41^{\prime}$ | $14^{\circ} 22^{\prime}$ |  |
| 081119 | 7 | 25 | $55^{\circ} 44^{\prime}$ | $14^{\circ} 18^{\prime}$ |  |
| 081119 | 8 | 25 | $55^{\circ} 42^{\prime}$ | $14^{\circ} 24^{\prime}$ | 1 |
| 081119 | 9 | 25 | $55^{\circ} 40^{\prime}$ | $14^{\circ} 19^{\prime}$ | 1 |
| 081119 | 10 | 25 | $55^{\circ} 39^{\prime}$ | $14^{\circ} 0^{\prime}$ | 4 |
| 081120 | 11 | 25 | $55^{\circ} 37{ }^{\prime}$ | $14^{\circ} 25^{\prime}$ | 5 |
| 081120 | 12 | 25 | $55^{\circ} 42^{\prime}$ | $14^{\circ} 22^{\prime}$ |  |
| 081120 | 13 | 25 | $55^{\circ} 41^{\prime}$ | $14^{\circ} 22^{\prime}$ | 4 |
| 081126 | 14 | 25 | $55^{\circ} 37$ | $14^{\circ} 26^{\prime}$ | 6 |
| 081126 | 15 | 25 | $55^{\circ} 37{ }^{\prime}$ | $14^{\circ} 25^{\prime}$ | 5 |
| 081126 | 16 | 25 | $55^{\circ} 41^{\prime}$ | $14^{\circ} 22^{\prime}$ |  |
| 081126 | 17 | 25 | $55^{\circ} 43^{\prime}$ | $14^{\circ} 19^{\prime}$ |  |
| 081126 | 18 | 25 | $55^{\circ} 38^{\prime}$ | $14^{\circ} 24^{\prime}$ | 9 |
| 081127 | 19 | 25 | $55^{\circ} 37^{\prime}$ | $14^{\circ} 24^{\prime}$ | 7 |
| 081127 | 20 | 25 | $55^{\circ} 40^{\prime}$ | $14^{\circ} 25^{\prime}$ | 5 |
| 081127 | 21 | 25 | $55^{\circ} 38^{\prime}$ | $14^{\circ} 26^{\prime}$ | 6 |

The length frequency distribution of cod $<20 \mathrm{~cm}$ shows that the largest portion of cod $<20 \mathrm{~cm}$ was between 14-19 cm (Fig. 2). Otoliths of young cod will be analysed to determine their age.

## Comparison of JOIFISH/Lot8 CRS and ARGOS BITS survey

Creating a survey that calculates indices for assessment purposes takes long time and meticulous preparations. The survey conducted under JOIFISH/Lot8 is mentioned as a feasibility study and all comparisons are on a very primary level. It should only be considered in the context of 'If this is a feasible way to work in the future?'.

The two surveys are preformed with two quite different vessels and size of gears which make a direct comparison not possible. As a preliminary exercise some comparison of length distribution and no/hours of fishing has been done (Fig 2). But at this stage they should be a foundation for any conclusions towards the recruitment index.
The result shows that few cods below 20 cm were caught by SIN 18 Vingarö. There is no direct explanation for this pattern since this size should be recruited to the type of mesh size used.
The cod caught by Argos between 4-12 cm are not aged yet but is very likely to be born in 2008 and therefore age 0, i.e. the incoming year class. Argos performed most of their hauls in a deeper area ( $40-66 \mathrm{~m}$ ) than SIN 18 (21-60m). Argos however caught cod between 4-16 cm but this part of the length distribution were absent in the catch from SIN 18.

The relative length frequencies of small cod in the catch (Fig 3) shows that SIN 18 Vingarö has proportionally higher frequency of lengths $13-19 \mathrm{~cm}$ in the catch.


Fig. 2: Length distribution of cod compared between Argos BITS expedition November 2008 and JOIFISH/LOT8 Cod Recruitment Survey with fishing vessel SIN 18 "Vingarö"


Fig. 3: Length distribution of cod $<20 \mathrm{~cm}$ compared between Argos BITS expedition November 2008 and JOIFISH/Lot8 Cod Recruitment Survey with fishing vessel SIN 18 "Vingarö"

Sampling of water shallower than 20 m was proved difficult even with a small flexible fishing vessel. Only two hauls were performed on depth less than 30 m and then had to be abandoned due to risk of damaging the gear.

## 5. Cooperation between Fishery and Fishery science

Skipper Viberg was very active in planning and execution of the survey was uncomplicated. The crew was very communicative, flexibly in work times and pleasantly.
The cruise was somewhat in jeopardy due to the weather conditions. The will of the skipper was however strong to fulfil the assignment and it was conducted over two periods over two weeks.

## 6. Acknowledgement

We tank Skipper Olle Viberg and his crewmember Bengt Viberg as well as the scientific cruise participant Fredrik Nilsson for their very constructive and motivated work

## 10 Annex 5: Polish research project

Title: "Determining the magnitude of discards in Baltic cod catches and further action with regard to them if no-discard fishery is implemented"

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EU call FISH/2006/15 - Lot8:
"Joint data collection between the fishing sector and the scientific community in the Baltic Sea"

# "Determining the magnitude of discards in the Baltic cod catches and further action with regard to them if no-discard fisheries is implemented" 

by
Sea Fisheries Institute in Gdynia
Poland

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Dr Szymon Bzoma - project's logistics

## Project coordinator: Dr Zbigniew Karnicki

Gdynia, December 2008

## Introduction

The main goal of the project was to determine the magnitude of discards in Polish cod fisheries by strengthening the co-operation between fisheries scientists and fishing sector. Joint data collection was expected to provide data of good quality on real levels of by-catches and discards which will also be used for recognizing problems associated with landings of the whole catch (landings and discards) in case of no-discard fisheries implementation (COM(2007) 136 final). Polish part of the EU Lot8 project had begun in January 2008 and was delayed by 6 months as compared to initial plan due to cod ban on Polish fisheries for the second half of 2007. Data collection was finalized on 30 of June 2008 due to temporal termination of Polish cod catches implemented by Ministry of Agriculture and Rural Development.

## Materials and methods

## General information

For the purpose of the project four fishing vessels were randomly selected from the list of vessels grouped according to vessel type (trawlers and gillnetters) and also representing eastern (ICES Sub-division 26) and western (ICES Sub-division 25) waters of Polish coast (taking into account location of home-ports). List of vessels was provided by fishermen organizations which next participated in public selection of vessels for the project.

Vessels selected from the list represented two gillnetters ( 18 m and 17.5 m length) and two trawlers - 14.8 m length (fishing with BACOMA codend) and 22 m length fishing with turned meshes in codend -T90). One trawler and one gillnetter were exploiting fishing grounds in eastern part of the Polish EEZ and another trawler and gillnetter were operating in western part (Figs. 1 and 2). The choice of any fishing ground depended on skipper's preference. According to the project concept the whole catch including unwanted by-catch and discards by species (as classified by the crew) were obligatory landed in only three assigned fishing auctions. Selling fish outside fishing auctions was prohibited.

It was intended to cover fishing trips with an observer on board (either scientist or fish inspector) to the highest possible degree. The role of the observer was to record the weight of the catch divided by species, separately for landed and discarded part of the catch. It was also observer duty to measure fish species. In case of no-observer trips no length measurements were made but registering the weight of species was the responsibility of the skippers who were prepared for that role by the Institute staff. Haul (or gillnet set) information registering was led on the forms which allowed for data writing down with higher level of resolution than it is possible with currently used fishermen logbooks. Haul information forms were very much in line with the forms which are commonly used in FishFrame international database designed for registering commercial fishing fleet sampling data in the Baltic Sea area. Hand written forms were delivered (either by mail or submitted personally in case of trip with Institute scientist on board) to the Institute for computer database recording. Copies of log-books and first sale document were submitted in accordance with regulations in force to the Fisheries Monitoring Centre to be entered into the
system. These data were later available to the project for comparison where necessary.
Trips with scientific staff onboard were also investigated in terms of biological parameters of the catch. Observers on board measured landing and discard samples of cod and flounder. Cod samples were taken from every second haul or gillnet set while for flounder from every third haul/gillnet set. Randomly taken fish samples (after fishermen's sorting by species and sorting by catch categories - discard, landing) usually consisted of 100 individuals (separately for discard and landing). In total 28 509 and 11907 landed and discarded individuals of cod respectively was measured and in case of flounder 3917 landed and 4858 discarded flounder was measured. Detailed ichthyologic analysis of cod catches were performed on land at fishing auctions. Stratified drawing by length of cod for detailed biological analysis was done in order to determine the following parameters of cod: length of fish, individual mass, sex, maturity stage, stomach fulfilness and age. In total 518 cod specimens was aged. No ichthyologic analysis of by-catch species was conducted.

## Estimation of cod discards magnitude

Magnitude of cod discards was estimated by applying three different procedures of raising discard data since the quantity of both landings and effort information (fishing days and trips) were available at the population level (fishing fleet segments consisting of vessels having the same vessel length range - as defined in DCR, the same gear type as well the same time and geographical assignment as represented by the four vessels of the project) (Table 1). Data on cod landings, number of trips and number of fishing days of four selected fishing vessels were assigned according to the following strata: ICES Sub-division, quarter and type of gear, as it is used to be applied in the assessment of Baltic cod by the ICES Baltic Fisheries Assessment Working Group. Finally the results of cod discard estimates on the sampling level (represented by four vessels of the project) divided per strata were then raised to population level (Table 1).

Raising by landings
First the sample ratio per stratum was calculated by dividing the total weight of cod discards in the stratum/total weight of cod landings in the stratum. The sample ratio per stratum was applied to total landings of target species (cod) available on the landings stratum level defined as DCR fleet segment, fishing gear - level 1, quarter and ICES Sub-division.

Raising by sampling unit
Raising by trips
Sample mean discards in the stratum has been calculated by dividing the sum of observed discarded quantity (weight) in sampled trips/number of trips sampled. Raising sample mean discard obtained for trip in a given stratum by the known number of trips at the population level total discards in a given stratum was obtained.

Raising by fishing days
The same approach was applied to raising by fishing days method. Similarly to trips, sample mean discards in the stratum was calculated by dividing the sum of observed discarded quantity (weight) in sampled fishing days/number of fishing days sampled. Sample mean discards was raised by known number of fishing days at the population level.

There was also an intention to raise discards by fishing operations, however that variable was not available at the population level.

Magnitude of other species discards is given as the sum of that catch category as registered in log-books.

## Results and discussion

## Fishing areas of four vessels

Vessels involved in the project operated mainly on fishing grounds located relatively close to their home ports. Figures 1 and 2 show geographical distribution of cod yields (each point or circle represents location of realized hauls or set of gillnets) by month in kg per hour, separately for catch categories (landing and discard part of cod catch) as classified by the fishermen. Size of the circles is scaled to maximum value of the yield obtained in one of the hauls (or gillnet sets) separately for cod landings and cod discards. Therefore yields of cod might be compared between trawlers (Fig. 1) and gillnetters (Fig. 2), within catch categories of the same fishing gear.

Trawler KOŁ-73 was operating in January, February and in June mainly in southern part of the Bornholm Basin (Fig. 1.) on the depth of around the isobath of 60 m (thin solid line on the maps) obtaining lower yields of cod landings than the observed


Figure 1. Geographical distribution of cod yields in trawl catches of the vessels KOK-73 and WŁA-161.
ones in March-May period, and conducted on deeper waters above the isobath of 60 m . In February and in March there were noted relatively highest yields of cod discards, which occurred however in only several hauls. Relatively significant discard in these months might be the impact of considerable by-catch of flatfishes (mainly flounder) observed in $1^{\text {st }}$ quarter (Fig. 9). Another trawler, WŁA-161 was fishing in January-February period in the eastern part of Słupsk Furrow. The yields obtained there were markedly lower in comparison with the yields noted in May and in June, when that vessel changed its fishing grounds for the western part of Sub-division 26. Distribution of cod yields obtained by gillnetters is shown on Figure 2. Both vessels conducted catches in the region of Słupsk Furrow. However the trawler WŁA-161 was fishing in central part of Słupsk Furrow only in January and in February, while during the next months its catches were conducted mainly in eastern part of Słupsk Furrow and in western part of Sub-division 26. Yields of cod landings in January and
in February were very similar comparing the two gillnetters while during the months of March, April and June the yields of the vessel WŁA-57 were higher than the yields of the vessel DAR-25, which was still exploiting in those months the central and western part of Słupsk Furrow. So, the change of fishing ground was profitable for vessel WŁA-57. In case of both vessels the yields of cod discards remained highest in March, April and in June. The discard pattern was very uneven in geographical context.


Figure 2. Geographical distribution of cod yields in gillnet catches of the vessels DAR-25 and WŁA-57.

## Length distributions of cod landings and discards

Length measurements of cod were conducted separately for cod samples of discard and landing as classified by fishermen. For each of the catch category a sample of approximately 100 cod individuals was taken. Length frequency of each sample was raised to catch level of the corresponding catch category in a given haul/gillnet set. Length distributions of cod landings and discards by month for each vessel participating in the project are presented on Figure 3.
Length distributions of cod landings indicate that in case of gillnet catches cod individuals of larger size were more frequently represented than in trawl catches. That phenomenon is in particular evident in first quarter when peaks (modal lengths) of length distributions of cod fished with gillnets are moved to the right on the X axis in comparison with length distributions obtained for trawl catches. In June however, length curves of cod landings represent very similar pattern for both fishing gears applied in the catches. Unfortunately the lack of length samples from the catches of the vessel DAR-25 in March, in April and in May as well for WŁA-57 in May make difficult full time scale comparison of length distributions between the fishing gears, although length frequency obtained in April from gillnets (WŁA-57) was more favorable than in trawls.
Realization of the Project involved application of two types of codends in trawls (codend with turned meshes - T90 and Bacoma type codend). It gave the opportunity to analyse length distributions for these types of codends, although region of catches were distant from each other. Modal lengths for these codends are
very close to each other in cod landings (except for February when clearly shift towards larger cod is observed for T90 codend), although in T90 the higher share of larger cod individuals (above 50 cm ) is marked. That fact can be explained by better hydrodynamic properties of turned meshes what enables filtering larger volumes of water and increasing the same the probability of catching larger cod. In addition it seems that the by-catch of flatfishes was significant factor decreasing selective properties of Bacoma codend. By-catch of flatfishes occurred until the April. Selective panel of squared meshes mounted on the top of Bacoma codend was probably clogged with flatfishes what made the filtering of water difficult. It seems that Bacoma is in general more vulnerable to decreasing selectivity due to by-catch of flatfishes. One of the features of landed cod from Bacoma codend was very narrow representation of length classes as compared to number of length classes found in T90 codend.


Figure. 3. Length distributions of cod discard and landing in the catches of four vessels by month.
Length distributions of discarded cod in gillnet catches were almost flat, what is the result of generally small cod discard occurring in gillnet fishing. In trawl catches length distributions of cod discards were characterized by well marked peaks. The top of the length frequency falls most frequently on 34 cm length class and its share varied between $0.5 \%-4 \%$. T90 codend retained less cod of smaller size. It shall be emphasized that fishermen classified cod for landing or discard, which were next measured by scientific staff. Because assignment of cod individuals to appropriate catch category was done mainly visually („by eye") therefore length curves of discards and landings overlap to some extent.

### 2.2.3. Age structure of cod in the catches of four vessels

Age structure of cod in trawl and gillnet catches was quite similar. (Fig. 4). The difference was evident for the youngest age group observed in the catches - age group 2 , which was more frequently observed in trawl catches than in gillnet catches. In addition, the share of age group 5 was higher in gillnet catches as compared to trawl catches. The two above mentioned differences in the share of age groups in the catches of these two gear types might be the result of higher flatfishes by-catch observed in trawl catches.


Figure. 4. Age distributions of cod in trawl and gillnet catch (discard and landing combined).
Combined age structure of both gears and catch categories presented as the share of year-classes indicated that cod born in 2005 dominated in four vessels catches (Fig. 5).


Figure. 5. The share of year-classes in the catches of four vessels.
The 2005 year-class also prevailed in the catches of Baltic international trawl research surveys conducted in 2007 (age group 2 in the year 2007). However, in the Baltic commercial fleet catches the share of 2005 year-class was low (approx. 10\%) (Fig. 6.).


Figure. 6. The share of year-classes in Baltic international trawl research surveys and in commercial catches in 2007 (data investigated by ICES in 2008).

The results of age structure determination from four vessels confirmed the signal on strength of 2005 year-class coming from research surveys. This probably also indicates that low occurence of age group 2 in commercial catches is the effect of good selective properties of fishing gears used in cod fishery, which decrease the bycatch of young cod.

## Cod maturity changes on the basis of four vessels catches

Biological investigations of cod catches included also the analysis of gonadal maturity


Figure 7. Cod gonadal maturity changes in the catches of four vessels.
development. The investigations revealed that in January dominated cod in gonadal stage 2 (resting). No cod individuals of gonadal stage 6 (spawning) were found in

January. Low share (1\%) of cod in stage 6 occurred in the investigations carried out in April indicates the beginning of cod spawning. Also in April there was observed clear change in proportions of stage 4 and 3 as compared to January. In June the share of stage 6 (spawning) reached $7 \%$ and also co-occurred cod with gonads in stage 7 (partially spawned). Nevertheless cod with gonads in stage 5 (approximately two weeks before spawning) definitely dominated in the catches (60\%). Such a high share of gonads in stage 5 indicate that time of cod spawning overlapped to large extent with summer ban (July-August) on catches recommended for eastern Baltic cod for 2008 by the Commission.

## Magnitude of cod discards in the catches of four vessels

Magnitude of cod discard (in mass) was registered for each fishing operation haul, gillnet set. Results of cod discard share in relation to total catch of cod (cod discard/[cod discard+cod landing]) for each fishing operation by months is given in Figure 8.


Figure 8. Cod discard share in total catch of cod (in terms of mass).
Share of cod discard in gillnet catches was low and varied between $0 \%-11 \%$. The overall average cod discard for gillnetters did not exceed 1\%, however. The distribution pattern of that parameter between months was rather uniform. Share of cod discard in trawl catches was much higher than in gillnet catches. Cod discard
occurred in almost all hauls performed reaching most frequently a few percents. The overall average cod discard for trawlers slightly exceeded 4\%. In trawl equipped with Bacoma codend, cod discard was higher by 0.23 percentage point than in T90 codend. Enlarged share of cod discard in catches of the vessel KOt-73 was mainly noted in $I^{\text {st }}$ quarter while in case of WŁA-161 cod discard occurred in April-May. It is worth to note that the same scale of cod discards was obtained in trawl and gillnet catches of cod in recent years as revealed in random sampling of fishing vessels carried out within National Sampling Programme co-funded by the European Union.

Considerable differences in share of cod discards between trawls and gillnets seems to be the most likely the effect of different susceptibility of the two types of gear for decreasing their selective properties due to flatfishes by-catch. By-catch (in terms of mass) of flatfishes (flatfishes mass/total mass of all species in the catch) for each fishing operation by month is shown on Figure 9. In case of gillnet catches no changes in cod discard share were noticed with regard to changes in by-catch of flatfishes. In spite of an increase in flatfishes by-catch in the catches of WŁA-57, in March-April no analogous increase in share of cod discard was observed, whereas in KOt-73 catches enlarged by-catch of flatfishes in $1^{\text {st }}$ quarter resulted in cod discard share increase. Similar rule was found in catches of WŁA-161, however the relationship between changes in by-catch of flatfishes and cod discard was not as evident as in the catches of the latter vessel. For instance in February in catches of WŁA-161 the largest by-catch of flatfishes occurred but the share of cod discard in that month was close to share in April, May when by-catch of flatfishes was markedly lower than in February. The phenomenon of decreasing selective properties due to by-catch of flatfishes in higher degree affects Bacoma codend, equipped with top panel of square meshes. Underwater video camera observations carried out during selectivity investigations of other projects revealed that flatfishes gather on the top of codend clogging meshes what results in larger by-catch of young cod an in this cod individuals of smaller sizes.


Figure 9. The share of flatfish by-catch in total catch of all species.

## Estimation of cod discards on the population level

As described in materials and methods, for the estimation of cod discard on the population level the following strata were distinguished taking into account ICES time (quarter) and space (ICES Sub-division) data resolution and EU fleet segmentation by length (DCR - Data Collection Regulation) and by fishing gear (white panel of the Table 1). Three raising methods were applied: by cod landings, number of fishing days and number of fishing trips. Finally magnitude of cod discards was estimated (green panel in the Table 1) by raising sampling level data (yellow panel in the Table 1) obtained during the project of four vessels by population level data (purple panel in the Table 1).

Table 1. Results of cod discards estimation in sampled strata.

| QUARTER | $\begin{array}{\|c} \text { ICES } \\ \text { SUB- } \\ \text { DIVISION } \end{array}$ | $\begin{array}{\|c\|} \hline \text { DCR } \\ \text { FLEET } \\ \text { SEGMENT } \\ \hline \end{array}$ | $\begin{aligned} & \text { FISHING } \\ & \text { GEAR } \\ & \text { LEVEL } 1 \end{aligned}$ | SAMPLING LEVEL DATA |  |  | POPULATION LEVEL DATA |  |  | DISCARD [kg] ON POPULATION LEVEL ESTIMATED BY: |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | discard/landing ratioin thestratum | mean discard <br> per fishing day <br> in the <br> stratum <br> $[\mathrm{kg}]$ | mean discard in fishing trip in the stratum [kg] | Landing <br> $[\mathrm{kg}]$ Number of <br> fishing <br> days |  | Number of fishing trips |  |  |  |
|  |  |  |  |  |  |  |  |  | Landings | Fishing days | Fishing trips |
| 1 | 25 | VL1224 | mobile gears | 0.058 | 85.20 | 147.46 | 581698 | 948 |  | 533 | 33680 | 80770 | 78596 |
| 1 | 26 | VL1224 | mobile gears | 0.039 | 45.64 | 66.70 | 361859 | 985 | 863 | 14004 | 44955 | 57562 |
| 1 | 25 | VL1224 | passive gears | 0.006 | 6.36 | 15.90 | 520057 | 998 | 661 | 3027 | 6347 | 10510 |
| 1 | 26 | VL1224 | passive gears | 0.003 | 5.20 | 13.28 | 212974 | 226 | 132 | 690 | 1175 | 1753 |
| 2 | 25 | VL1224 | mobile gears | 0.035 | 102.70 | 193.08 | 872218 | 710 | 385 | 30702 | 72917 | 74336 |
| 2 | 26 | VL1224 | mobile gears | 0.045 | 167.00 | 473.38 | 965149 | 749 | 540 | 43335 | 125083 | 255625 |
| 2 | 25 | VL1224 | passive gears | 0.010 | 13.36 | 38.25 | 670364 | 865 | 420 | 6623 | 11556 | 16065 |
| 2 | 26 | VL1224 | passive gears | 0.005 | 13.99 | 31.49 | 386349 | 312 | 159 | 1889 | 4365 | 5007 |
|  |  |  |  |  |  |  |  | TOTAL | DISCARD | 133951 | 347169 | 499454 |

The results of cod discard estimation strongly depend on raising method applied. The lowest estimated value of cod discard estimation (140 tons) was obtained applying the method of raising by landings. Results of that method differ from the method of raising by number of fishing days and number of fishing trips by 2.6 and 3.7 times, respectively. The two last methods gave more consistent results, although they differ by 1.4 times. Method of raising by landings is in general considered as low credible in case of known unreporting landing statistics.

## Total discard of all species in the catches of four vessels

In the following subsection total discard considered as a sum (in mass) of undersized fish and all unwanted by-catch of fish species (including individuals of legal size) and in this also fish under prohibition, like flounder ban in Sub-division 26 and further eastward in force from 15-th of February till 15-th of May is presented. In that sense, total discard declared (registered) by the crews of four vessels during the whole period of investigations varied between 0.3-13.1 tons, depending on fishing gear and Sub-division (Table 2). Low discard in the catches of the vessel WŁA-161 in Subdivision 25 is the result of relatively short and not intensive exploitation of fishing grounds in that Sub-division (Słupsk Furrow, see subsection Fishing areas of four vessels).
Much higher discard in Sub-division 26 results mainly from the ban on flounder fishing and therefore the whole by-catch of that fish species was classified as discard.

In general however, the share of discard in total catch was low reaching several percents. Overall total share of discard for the vessels involved in the project achieved $4.45 \%$. The result obtained in the light of the Commission intention to implement total ban on discards or where it is not possible significant reduction of
discards (COM(2007) 136 final) indicates that in Polish cod directed fisheries there shall be no problem with bringing discards ashore and utilizing it.

Table 2. Total discard of all species by fishing gears and ICES Sub-divisions.

| Fishing <br> vessel | ICES <br> Sub-division | Fishing <br> gear | Discard <br> [tons] | Share of discard <br> in total mass of catch <br> [\%] |
| :---: | :---: | :---: | :---: | :---: |
| WŁA-57 | 25 | gill-net | 2.170 | 7.57 |
|  | 26 | gill-net | 9.610 | 5.49 |
| WŁA-161 | 25 | trawl | 0.270 | 1.45 |
|  | 26 | trawl | 13.130 | 5.71 |
| DAR-25 | 25 | gill-net | 1.010 | 1.02 |
|  | 26 | gill-net | - | - |
| KOŁ-73 | 25 | trawl | 9.85 | 3.83 |
|  | 26 | trawl | - | - |
| TOTAL DISCARD | 36.050 | 4.45 |  |  |

The results of the project show that cod fishery is not mixed fishery and the by-catch of other species is in general low (Table 3). Even if there was larger by-catch of flounder as observed in the catches carried out in Bornholm Basin, it is species that is used for human consumption and therefore its discarding is not high.

## Species composition in the catches of four vessels

In the catches of four vessels cod was the dominant species exceeding $90 \%$ in mass (Table 3). In case of the vessel KOŁ-73 the share of cod reached 76\%.

Table 3. Species composition in the catches of four vessels (in \% of mass).

| VESSEL | Cod | Flounder | Plaice | Twaite <br> shad | Turbot | Whiting | MackerelFourbeard <br> rockling | DabShorthorn <br> sculpin |  |  |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| DAR-25 | $98.8027 \%$ | $1.1679 \%$ | $0.0000 \%$ | $0.0275 \%$ | $0.0000 \%$ | $0.0004 \%$ | $0.0013 \%$ | $0.0002 \%$ | $0.0000 \%$ | $0.0000 \%$ |
| KOL-73 | $75.9654 \%$ | $23.5393 \%$ | $0.4467 \%$ | $0.0027 \%$ | $0.0381 \%$ | $0.0062 \%$ | $0.0003 \%$ | $0.0002 \%$ | $0.0003 \%$ | $0.0002 \%$ |
| WLA-57 | $94.4954 \%$ | $5.4615 \%$ | $0.0006 \%$ | $0.0425 \%$ | $0.0000 \%$ | $0.0000 \%$ | $0.0000 \%$ | $0.0000 \%$ | $0.0000 \%$ | $0.0000 \%$ |
| WLA-161 | $95.7020 \%$ | $4.2866 \%$ | $0.0002 \%$ | $0.0000 \%$ | $0.0003 \%$ | $0.0000 \%$ | $0.0000 \%$ | $0.0000 \%$ | $0.0000 \%$ | $0.0000 \%$ |
| AVERAGE | $89.5026 \%$ | $10.3220 \%$ | $0.1423 \%$ | $0.0149 \%$ | $0.0122 \%$ | $0.0020 \%$ | $0.0002 \%$ | $0.0001 \%$ | $0.0001 \%$ | $0.0000 \%$ |

Except for cod the only important species in term of mass was flounder (10\% on average). By-catch of other species was very low and did not exceed $0.2 \%$. Some of the species like shorthorn sculpin, dab, fourbeard rockling and mackerel were represented during the whole period of investigations by several individuals only.

## Catches

The overall size of the catches of the vessels participating in the project for its duration was approximately 900 tons. The decided dominant in the catches was cod ( $90 \%$ ), with flounder contributing about $9 \%$ to the catch structure. Other species (e.g., plaice, turbot, whiting) occurred sporadically in the catches. The share of flounder bycatch in the landings of individual vessels was 1-4\%; only in the case of vessel KOL73 was the flounder contribution as high as $23 \%$, which contributed to the high catch
of these fish in the winter period (in January and February they contributed as much as $75 \%$ to the total catch of this vessel). The average catch size of cod per vessel was about 200 tons at a range of 115 to 280 tons per vessel. Generally, the vessels fishing with trawls achieved better catch results than did those fishing with fixed gear at a comparable number of days at sea.

Table 4. Catch size (in kg ) and fishing effort (in days) of four cutters by fish species

|  | Vessel <br>  <br>  <br> length $(\mathrm{m})$ | Gear |  |  |  | Catches |  |  |  |
| :--- | ---: | :--- | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
|  |  | cod | flounder | other | Total | cod | other | Total |  |
| KOL-73 |  | trawl | 216954 | 64721 | 968 | 282644 | 69 | 19 | 88 |
| WLA-161 | 21.98 | trawl | 278715 | 13118 |  | 291833 | 90 | 3 | 93 |
| DAR-25 | 18.03 | nets | 115095 | 862 | 31 | 115989 | 86 |  | 86 |
| WLA-57 | 17.55 | nets | 208169 | 6975 | 154 | 215298 | 97 | 97 |  |
| Total |  |  | $\mathbf{8 1 8 9 3 4}$ | $\mathbf{8 5 6 7 6}$ | $\mathbf{1 1 5 4}$ | $\mathbf{9 0 5 7 6 4}$ | $\mathbf{3 4 2}$ | $\mathbf{2 2}$ | $\mathbf{3 6 4}$ |

${ }^{1}$ days targeting a given species, determined by the dominant species on a given fishing day


Figure 10. Catch structure of four cutters (tons).
The catches of the vessels participating in the program (both trawlers and net) were concentrated in the spring-summer period. More than half (54\%) of the cod landed were


Figure 11. Monthly catches of four cutters (in tons)
caught in May and June. This was the result of better catch yield during the prespawning period when concentrations of this fish are high, as well as from the higher cod prices in June resulting from the closure of the commercial cod fishery at the end of May.

## Catch efficiency (CPUE)

The vessels participating in the program achieved a mean catch-per-unit-effort (CPUE) of 2.3 tons of cod per fishing day. The highest CPUE during the project was achieved by WLA-161 deploying a trawl with a codend with T90 meshes, which resulted primarily from the excellent catches it made in June. Slightly lower yield was achieved by vessel KOL-73, despite this vessel being decidedly smaller than WLA161. Although the vessels fishing with fixed gear had similar technical parameters and were working in fishing grounds that were not far apart, their catch efficiency differed substantially. These differences are difficult to explain since they did not stem from different numbers of gear or seasonal changes in catch efficiency.

Table 5. Catch efficiency in days targeting cod

| External mark | Catches (tons) | Days | CPUE (tons/day) |
| :--- | ---: | ---: | ---: |
| KOL-73 | 196.2 | 69 | 2.84 |
| WLA-161 | 278.3 | 90 | 3.09 |
| DAR-25 | 115.1 | 86 | 1.34 |
| WLA-57 | 208.2 | 97 | 2.15 |
| Total | $\mathbf{7 9 7 . 8}$ | $\mathbf{3 4 2}$ | $\mathbf{2 . 3 3}$ |

Figure 12 illustrates the daily CPUE of the four cutters by month. Surprisingly high CPUE (the highest of all the vessels) was achieved by KOL-73, the smallest vessel. Excluding January and February (when flounder dominated this vessel's catches), this vessel had decidedly higher yield than did the other vessel fishing with a trawl (WLA-161). This could be explained by the different areas these vessels fished and the different periods of cod concentrations. Vessel KOL-73 fished mostly in the Bornholm fishing grounds (ICES square 38G5) exploiting the early spring cod concentrations. Cutter WLA-161 fished the Wladyslawowo fishing grounds (ICES square 39G8), and a decided improvement in efficiency happened in June during the pre-spawning concentration of cod in this region.


Figure 12. Daily fishing efficiency in the targeted cod catches of four cutters by month.

## Summary of catches

Table 6 presents a synthetic comparison of the basic catch data of four cutters with that of vessels from four similar length categories (12-15m, 16-18m, 19-20m, 21$23 \mathrm{~m})$. Generally, it is notable that decidedly better results were achieved by the four vessels participating in the project than the mean results of the other vessels with similar technical parameters. These differences are evident in catch size, fishing days, and catch efficiency (CPUE).

Fourteen fishing vessels $12-15 \mathrm{~m}$ in length (excluding those participating in the program) caught a total of 145 tons of cod in the analyzed period, which is more than 50 tons less than the catch of the KOL-73 alone. The mean efficiency per hour in this group of vessels was 47 kg at a maximum of $112 \mathrm{~kg} / \mathrm{h}$; both of these figures were also lower than the mean efficiency of KOL-73 (130 kg/h).

The next length category of vessels $(16-18 \mathrm{~m})$ caught a total of 1.1000 tons, with a mean of catch of 24 tons per vessel. This was nearly ten-times less compared to the vessel WLA-57 participating in the program. The mean number of fishing days was, however, also lower than that of vessels participating in the project. The greatest differences in this group were noted in catch efficiency, which was $80 \mathrm{~kg} / \mathrm{h}$ for the vessel participating in the project and a maximum of $47 \mathrm{~kg} / \mathrm{h}$ for the other vessels.

The small group of vessels measuring 19-20m (4 vessels) that fished with nets achieved the closest mean catch efficiency to that of the vessel participating in the project. Vessel DAR-25 achieved a mean catch efficiency of about $50 \mathrm{~kg} / \mathrm{h}$, while the remaining vessels achieved a mean of $36 \mathrm{~kg} / \mathrm{h}$, with the best result at $42 \mathrm{~kg} / \mathrm{h}$. Although vessel DAR-25 had more fishing days, it caught nearly the same quantity of cod as the three other vessels combined.

The catch results of vessel WLA-161 were also significantly better than those of the other vessels not participating in the program. Its catches were about 280 tons, while the maximum catches of vessels not participating in the program were about 50 tons. The number of fishing days of the vessels in the project group was higher than the maximum number of fishing days of the other vessels in the same length category. The mean efficiency of cutter WLA-161 was 111 kg per fishing hour, and was significantly higher than the mean efficiency of vessels not participating in the program. It was, however, similar to the efficiency of the best vessel outside of the project group ( $96 \mathrm{~kg} / \mathrm{h}$ ).

Table 6. Comparison of catch results of four cutters with those of the other vessels in the same length category

|  | trawl |  | nets |  | nets |  | trawl |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | 12-15m | KOL-73 | 16-18 m | WLA-57 | 19-20 m | DAR-25 | 21-23m | WLA-161 |
| Number of vessels | 14 | 1 | 47 | 1 | 3 | 1 | 16 |  |
| Combined catches | 145 | 217 | 1124 | 208 | 114 | 115 | 547 | 279 |
| mean per vessel |  |  | 23.9 |  | 38.0 |  | 34.2 |  |
| maximum | 18.6 |  | 49.8 |  | 77.4 |  | 51.4 |  |
| minimum | 0.1 |  | 0.1 |  | 7.1 |  | 18.8 |  |
| Fishing days (U) | 97 | 69 | 1476 | 97 | 104 | 86 | 482 | 90 |
| mean per vessel |  |  | 31 |  | 35 |  | 30 |  |
| maximum | 39 |  | 52 |  | 55 |  | 62 |  |
| minimum | 2 |  | 1 |  | 16 |  | 13 |  |
| mean CPUE (kg/h) | 47.5 | 130 | 28.7 | 80,4 | 35.8 | 49,5 | 40,8 | 111 |
| mean CPUE (kg/h) | 112.6 |  | 47.6 |  | 42.2 |  | 96.4 |  |

The four vessels participating in the program had significantly better results than did the other vessels of similar technical parameters. This was primarily due to the lack of individual catch limits imposed on the vessels in the study. Additionally, the participating vessels were allowed to fish for a month longer in June when the mean catch yield was the highest. The vessels fishing under commercial guidelines were forced to stop fishing on May 22 as stipulated by the regulation issued by the Ministry of Agriculture and Rural Development. The full monitoring of the landings of the participating vessels also contributed to the better reliability of the catch data in comparison with that collected from the commercial vessels.

## Project summary

The project confirmed that, if fishing gear is used appropriately - in the cod fisheries of ICES Sub-divisions 25-26 - the share of discards in the entire catch is generally low. The total discard of the four vessels participating in the project was 4.5 percent. In light of the European Commission's intention of introducing a total ban on discards or, where this is impossible, to reduce them significantly (COM(2007) 136 final), it was concluded that if the share of discards in all Polish cod catches is of the same order of that in the current study, the utilization of them on land should pose no problem.

In cod trawl fisheries, especially with Bacoma selective windows by-catch increases with increased catch of flounder.

The catch results achieved by the vessels participating in the project were unexpectedly high and illustrated the significant fishing power of the vessels deploying both trawls and fixed gear. This is particularly clear in comparison of the CPUE of the vessels working within the guidelines of available quotas and the vessels operating under the auspices of this project. Applying the CPUE of the participating vessels to the entire Polish fleet fishing cod demonstrates clearly that its fishing power is definitely too high compared to the available catch quota and should be limited.

All of the biological data collected during the project, which could be useful in stock assessment, will be delivered to the appropriate working groups.
Data collected during the project will be used in preparation of separate reports on the selectivity of Bacoma and T90 codend as well as accidental catch of small cetaceans.

The present study was restricted to a limited time period and only four vessels. Therefore, it has to be noted that conclusion drawn from the project needs to be taken with caution and as preliminary.

# 11 Annex 6: Estimating abundances of 0-group Western Baltic cod by using pound net fisheries 

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# Estimating abundances of 0-group western Baltic cod by using pound net fisheries 


#### Abstract

Nearshore 0 -group western Baltic cod are frequently caught as bycatch in the commercial pound net fishery. Pound net fishermen from Funen, Lolland and Fehmarn have recorded their catches of small cod between September and December 2008. Abundance patterns were analyzed, particularly concerning the influence of abiotic factors (hydrography, meteorology) and the differences between sampling sites. Catch per unit effort (CPUE)differed by site and location, whereas CPUE were highest at Lolland. Wind directions and current speeds seem to affect catches, while wind strengths and current directions did not show close correlations to catches. Finally an algorithm is described to calculate an recruitment index for western Baltic cod recruitment success based of previous analyses.


Key words: Baltic Sea, 0-group cod, recruitment index, joint data collection, wind, currents, pound net, self-sampling

## Introduction

Cod is one of the most important fish species for Baltic commercial fisheries. The fishery management distinguishes between a western Baltic (Belt Sea, ICES SD 22-24) and an eastern Baltic cod stock (ICES SD 25-32) (ICES, 2008). Both stocks are separated by spawning area and spawning season (Bleil \& Oeberst, 2000; Nissling and Westin, 1997). Deeper waters of the Kiel Bay, the Fehmarn Belt and the Bay of Mecklenburg are the main spawning areas of the western Baltic cod (Bleil \& Oeberst, 2000) (Fig 1). Spawning activities of eastern Baltic cod were described for the Gotland Basin, Gdansk Deep and Bornholm Basin. Mixing of both stocks occurs primarily in the Arkona Sea (Nissling and Westin, 1997; Oeberst, 2000).

The spawning success of both stocks is influenced by hydrographical conditions, i.e. salinity, temperature and oxygen. Suitable spawning areas of the eastern Baltic cod stock are currently restricted to a subset of the historical sites (mainly the Bornholm Sea) due to unfavorable hydrographic conditions (Hinrichsen et al., 2008). However, this is not found to be the case for western Baltic cod. Cod eggs and early juvenile stages are found in the pelagial and their distribution, settling locations and finally survival, especially for the eastern Baltic cod depend on currents and wind-induced drifts (Hinrichsen et al., 2008). Little is known of the spatial and temporal distribution of juvenile Baltic cod. While the distribution of pelagic stages is influenced by currents, it is assumed that post settled juvenile
cod are more aggregated and concentrated in shallow coastal waters. Grant and Brown (1998) found that juvenile cod of Newfoundland remained localized, not moving further than a few hundred meters for several weeks after settling from pelagic habit. Methven and Schneider (1998) found the highest densities of postsettled age 0 cod at depths of $4-7 \mathrm{~m}$ in coastal Newfoundland. Similar observations were reported by German commercial fishermen.

Therefore, the Baltic International Trawl Survey (BITS) might not adequately cover the area distribution of 0 -group cod, resulting in a poor performance of the recruitment index derived from this survey.
Due to high fishing effort, the spawning stock biomass of western Baltic cod stock is dominated by first and second time spawners. This increases the importance of recruitment estimates for the prediction of stock abundance in fishery management (Oeberst \& Bleil, 2003). Nevertheless, successful methods to assess the recruitment and the strength of the new year class of the Belt Sea cod are rarely found. Hence, recent approaches were conducted by Bleil and Oeberst (2003) based on fecundity estimates.


Fig 1: Spawning areas of the western Baltic cod (yellow) (Bleil \& Oeberst, 2000).

The aim of this study was to establish a concept to estimate abundances of small cod in western Baltic coastal waters. Since traditional sampling with bottom trawl nets seem to be unsuitable, the data presented in this study are obtained using traditional coastal eel traps (pound net) (Fig 2). These traps are set close to the shoreline and pound net fishermen have reported high abundances of small cod, caught as bycatch, in the past, with most of the bycatch surviving. Sampling was conducted within the framework of JOIFISH/Lot8 ("Joint data collection between the fishing sector and the scientific community in the Baltic Sea"), a project in support of the Common Fisheries Policy. Commercial fishermen from Denmark and Germany were ask to record the bycatch of small cod during the entire pound net fishing season. This approach is the basis to increase the covered area and sampling period and hence to optimize the effort.

Based on this method, we present analyses of catch patterns of juvenile cod in pound nets, in the light of the question on the influence of abiotic factors (hydrography, meteorology) and the differences between sampling sites. Additionally, it has be evaluated, whether the data from pound net fishery could be used as recruitment index for western Baltic cod. If possible, a concept for the estimation of an index has to be developed and discussed.


Fig 2: Pound net - fish trap construction. The complex is deployed orthogonal to the coast line. Nets are fixed with picket. A long leading net causes fish to swim away from the coast into a court (pound) by passing a forecourt. Finally fishes are trapped in a bow net.

## Material and methods

## Catch

## Sources of data

The study areas are located in the western Baltic Sea, ICES SD 22. These areas are close to the main spawning areas of the western cod stock (Fig 1) (Oeberst, 2000) and are suggested to provide suitable habitat for 0-group cod.
Samples were carried out by Danish and German fisherman at Funen (Denmark, sites I-III), at Lolland (Denmark, sites IV-VI) and at Fehmarn (Germany, sites VII-XIII) (Fig 3) on a voluntary basis. Fishermen were instructed to complete a protocol after each haul (Appendix 1), whereas the overall design of German and Danish protocols was standardized, some minor differences in the protocol occurred, which resulted in some inconsistencies in the data.

Samples were taken from September to December in 2008. However, sampling periods differed for each site (Table 1). Similarly, catch durations were not constant (Appendix 2), ranging from 24 to 168 hours. Pound nets were used to catch cod (Fig 2). The pound nets differed by the length of the leader net and the numbers of fishing traps. Cod were sorted by length into three different size classes ( 0 $20 \mathrm{~cm} ; 20-38 \mathrm{~cm} ;>38 \mathrm{~cm}$ ). These size classes were chosen due to results of prior studies, which have shown, that the 0 -group in $4^{\text {th }}$ quarter of the year usually include fish with lengths smaller than 20 cm . The delimitation between size group 2 and 3 at 38 cm is the minimum landing size. The amount of cod per size group was estimated by fishermen in numbers per size group $(0-20 \mathrm{~cm}$ and $20-38 \mathrm{~cm})$ and as weight per size group $3(>38 \mathrm{~cm})$. These data were noted in a protocol (Appendix 1), data about further fish species, like eels were not recorded. After measurements and counting cod were released (size class $1 \& 2$ ) or used for commercial purposes by the fishermen (class 3 ). In addition, samples of small cod ( approx. 1 kg per sample) were taken regularly for further investigations at the institute. These samples were frozen at $-20^{\circ} \mathrm{C}$ and analyzed at the institute for Baltic Sea Fisheries Rostock (OSF) or at the National Institute of Aquatic Resources, Charlottenlund (DTU-Aqua). The analysis of these samples were conducted for every fish and included length measurement, total weight, gutted weight, and otolith sampling, whereas gutted weight measurements were not consistent. Otoliths were collected for age determination in accordance to ensure, that fish in this size category belong to the 0 -group.


Fig 3: Sample sites of cod recruits in pound net fishery. Sites I-III were located at northwestern coast of Funen Island , next to the Little Belt. Sites IV-VI were located at the southwestern coast of Lolland. Sites from Fehmarn (VII-XIII) are grouped in sites at northern Fehmarn (sites VII-X), southeastern Fehmarn (site XI) and southern Fehmarn (sites XII-XIII). For geographical positions, please refer to Table 1. (source: Google Inc.)

Table 1: Position and depth of the fishing sites grouped by location

| site | location | position | depth | sampling period |
| :---: | :---: | :---: | :---: | :---: |
| I |  | $55^{\circ} 25^{\prime} \mathrm{N}, 9^{\circ} 46{ }^{\prime} \mathrm{E}$ | 2m | 13.Oct. - 10.Nov. |
| II | Funen | $55^{\circ} 27^{\prime} \mathrm{N}, 9^{\circ} 43{ }^{\prime} \mathrm{E}$ | 3 m | 13.Oct. - 10.Nov. |
| III |  | $55^{\circ} 29{ }^{\prime} \mathrm{N}, 9^{\circ} 43{ }^{\prime} \mathrm{E}$ | 4 m | 13.Oct. - 11.Nov. |
| IV |  | $54^{\circ} 41.03^{\prime} \mathrm{N}, 11^{\circ} 17.69^{\prime} \mathrm{E}$ | 4.5 m | 05.Oct. - 17.Nov. |
| V | Lolland | $54^{\circ} 41.26{ }^{\prime} \mathrm{N}, 11^{\circ} 16.72^{\prime} \mathrm{E}$ | 6 m | 05.Oct. - 22.Nov. |
| VI |  | $54^{\circ} 42.03 ' \mathrm{~N}, 11^{\circ} 13.76{ }^{\prime} \mathrm{E}$ | 6.5 m | 05.Oct. - 22.Nov. |
| VII |  | $54^{\circ} 31.502^{\prime} \mathrm{N}, 11^{\circ} 08.780^{\prime} \mathrm{E}$ | 4 m | 18.Sept. - 28.Nov. |
| VIII | nortern F | $54^{\circ} 31.850^{\prime} \mathrm{N}, 11^{\circ} 06.284^{\prime} \mathrm{E}$ | 4 m | 29.Sept. - 12.Nov. |
| IX | rthern Fehmarn | $54^{\circ} 30.160^{\prime} \mathrm{N}, 11^{\circ} 14.134^{\prime} \mathrm{E}$ | 4 m | 19.Sept. -28.Nov. |
| X |  | $54^{\circ} 24.600^{\prime} \mathrm{N}, 11^{\circ} 13.170^{\prime} \mathrm{E}$ | 3.5 m | 28.Sept.-11.Dec. |
| XI | southeastern Fehmarn | 54²4.441' N, 11 ${ }^{\circ} 16.018^{\prime} \mathrm{E}$ | 4 m | 11.Sept. -11.Dec. |
| XII |  | $54^{\circ} 22.139^{\prime} \mathrm{N}, 11^{\circ} 07.421^{\prime} \mathrm{E}$ | 3 m | 11.Sept. -23.Nov. |
| XIII | southern Fehmarn | $54^{\circ} 21.786^{\prime} \mathrm{N}, 11^{\circ} 06.592^{\prime} \mathrm{E}$ | 4 m | 11.Sept. -05.Dec. |

## Analyses

Prior to further analysis, it was necessary to standardize the catch data. The catch per unit effort (CPUE) was calculated based on the time of deployment of the net, since increasing catch durations were assumed to be followed by increasing catch. Therefore, catch per 6 and 24 hours were calculated (depending on the type of analysis). Though, according to individual catch durations total catch was divided by the number of 6 h or 24 hour intervals (e.g. catch duration $=48 \mathrm{~h}$; Total catch $=80$; Catch per $24 \mathrm{~h}=40$; Catch per $6 \mathrm{~h}=10$ ). Hence, samples without details about catch duration, first hauls from Denmark were disregarded (Appendix 2). Catch per 24 hours was used to evaluate the underlying hypothesis. Total catch-catch duration and CPUE-catch duration relationships were analyzed for all sample areas. Additionally, varying abundances of different sampling sites and areas and the temporal development of CPUE for all sampling sites were calculated and compared based on 24h-CPUE.
Catch per 6h-intervall was used for analyses concerning wind and current-catch relationships (see below).

Although all laboratory samples were treated, only samples from Fehmarn were analyzed, because at the time of our analysis results from Denmark were not available to us.
Reading otoliths and therefore age determination of cods brought to laboratory was not possible, since distinguishing of false rings and annuli was not feasible (Fig 4).
Since size groups of cod were neither measured nor counted accurately by fishermen, length weight frequencies of laboratory samples were analyzed to determine accuracy of the estimate. Furthermore length frequency distributions including associated median and average length were calculated for each laboratory sample. Fractions greater 20 cm were however not excluded by these calculations. Medians of frequency distributions were used to estimate the mean daily growth (DG) of the total sampling period via linear regression. Based on estimated DG, length frequency distributions of laboratory samples were corrected/shifted to a hypothetical length distribution at closest mid month date (e.g. sampling date $=10$. Oct.2008, closest mid month date $=15$. Oct.2008) .
Length distributions, which are shifted to the same date (15.Sept. 2008; 15.Oct. 2008; 15. Nov. 2008; 15.Dec. 2008) were summarized. Finally length frequency distributions including associated median and average length for each mid-month were calculated. Medians were used to determine temperature dependent growth (see below) and specific growth rate for length per day.

Table 2: Sources of additional hydrological and meteorological data

| source | location | position | period | intervals | data | unit | data specifications |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| data logger | northern Fehmarn | $54^{\circ} 22.14{ }^{\prime} \mathrm{N}, 11^{\circ} 07.42^{\prime} \mathrm{E}$ | 12.Sept-6.Dec. 2008 | 30 min | w ater temperature | ${ }^{\circ} \mathrm{C}$ |  |
| DWD | Fehmarn, station 10055 | $54^{\circ} 31.98{ }^{\prime} \mathrm{N}, 11^{\circ} 03.96{ }^{\prime} \mathrm{E}$ | Sept.-Dec. 2008 | 24 h | air temperature w ind force | ${ }^{\circ} \mathrm{C}$ <br> Beaufort | max., min. and average values average |
| w etteronline.de | station Westermarkelsdorf | 54²8.02' N, 11¹3.20' E | Sept.-Dec. 2008 | 6 h | w ind direction | Degrees |  |
| BSH | Funen | $55^{\circ} 27.18^{\prime} \mathrm{N}, 09^{\circ} 43.92^{\prime} \mathrm{E}$ | Sept.-Dec. 2008 | 15 min | w ind speed | $\mathrm{m} / \mathrm{s}$ | delivered in $\mathrm{x}, \mathrm{y}$ and z -directions |
|  | Lolland | $54^{\circ} 41.64{ }^{\prime} \mathrm{N}, 11^{\circ} 16.56{ }^{\prime} \mathrm{E}$ |  |  |  |  |  |
|  | northern Fehmarn | $54^{\circ} 31.74{ }^{\prime} \mathrm{N}, 11^{\circ} 08.76{ }^{\prime} \mathrm{E}$ |  |  | w ind direction | Degrees |  |
|  | southeastern Fehmarn | $54^{\circ} 24.24{ }^{\prime} \mathrm{N}, 11^{\circ} 14.58^{\prime} \mathrm{E}$ |  |  | currents | $\mathrm{m} / \mathrm{s}$ |  |
|  | southern Fehmarn | $54^{\circ} 21.60{ }^{\prime} \mathrm{N}, 11^{\circ} 07.08^{\prime} \mathrm{E}$ |  |  |  |  |  |

The specific growth equation from Hawkins et al. (1985) is given in formula 1:

Formula 1: $\quad \mathrm{G}_{\mathrm{L}}=\left(\ln \mathrm{L}_{2}-\ln \mathrm{L}_{1}\right) * \mathrm{t}^{-1} * 100$
$\mathrm{L}_{1}$ and $\mathrm{L}_{2}=$ subsequent medians of mid-month length frequency distributions. $\mathrm{t}=$ time in days.


Fig 4: Otoliths of small cod brought to laboratory

## Abiotic data

## Temperature

## Sources of data

Water temperature at Fehmarn, (site XII Table 1) was recorded every hour with a HOBO PRO V2 water temperature logger (WTL) for almost the entire sampling period (12. Sept. to 06. Dec. 2008). Air temperature data was obtained from Deutscher Wetterdienst (DWD, www.dwd.de) for DWDstation 10055. This data series contains 24 h values of minimum, maximum and average temperature 2 m above bottom from 1. September until the end of December 2008 (Table 2).

## Analyzes

To estimate temperature dependent daily growth, water temperature values were averaged for each sequenced mid-month to mid-month interval (MMI) (15.Sept.-15.Oct.; 15.Oct.-15.Nov.; 15.Nov.15.Dec.). Medians of previously calculated mid-month length distributions (see above) were used to estimate absolute growth during MMIs. MMI-averaged temperature-values were plotted against MMIabsolute growth values to determine temperature dependent absolute growth.
Additionally, medians of mid-month length distributions were averaged for each MMI. Percentage growth during MMIs was calculated by dividing MMI-absolute growth values by these averages.

MMI-averaged temperature-values were plotted against MMI-absolute growth values to determine temperature dependent percentage growth.

Secondly, the air and water temperature, as well as temperature changes effects on catch were analyzed:

Water temperature was averaged per day. Linear regression was used to calculate the trend of water and air temperature during the sampling period. Deviations from temperature trend (DTT) were calculated, for both, air and water temperature. DTT-values of previous days were assigned to CPUE-values of juvenile cod (see above) from Fehmarn according to catch duration. Hence, DTT-values were averaged according to catch durations, if catch durations were $>24 \mathrm{~h}$.

## Wind

## Sources of data

Fishermen recorded wind speed (in bft) and wind direction during heaving the nets. No information was given for the catch period itself (often several days; Appendix 2). Hence, additional data were obtained from Deutscher Wetterdienst (DWD, www.dwd.de), WetterOnline Meteorologische Dienstleistungen GmbH (www.wetteronline.de) and Bundesamt für Seeschifffahrt und Hydrographie (Federal Maritime and Hydrographic Agency, BSH, www.bsh.de) (Table 2).
Apart from air temperature, data from DWD also contained values of wind force in Beaufort scale. Since data about wind direction were not freely available from DWD, these values were acquired from wetteronline.de. However, intervals of wind force (wetteronline.de) and wind direction (DWD) data differed (Table 2), leading to the problem how to average different wind directions per day (e.g. averaging $360^{\circ}$ and $20^{\circ}$ results in $190^{\circ}$ ). To avoid this problem a third source which provides wind strength or both, wind direction and wind strength data in shorter intervals was sought. Another problem concerning DWD and wetteronline.de-data was, that these sources did not provide data from Funen and Lolland. All these requirements were achieved by BSH-data (Table 2). Three stations were chosen, one per area, whereas northern Fehmarn-BSH-station was used for all sampling sites around Fehmarn (VII-XIII), since there was assumed that wind directions and strength are similar for these sites.

## Analyses

BSH-wind data were averaged per 6h interval using arithmetic mean, whereas wind speed values were converted in Beaufort scale. To analyze the quality of averaged data, estimated 6h-interval values of wind directions were compared with values from wetteronline.de using linear regression and time series plots. Furthermore, the temporal development of measured values were compared with raw data from BSH. Additionally, latter plots were used to evaluate constancy and differences of wind data between areas.

Wind rose diagrams were used to assess the dominance of different wind directions and forces. Distribution patterns of different wind strengths concerning based spatial directions were also analyzed using wind rose diagrams. In both cases 6h-average values based on BSH-data were applied.

Effects of different wind directions and wind forces on juvenile cod abundances were analyzed.
Total catch values were divided by the number of 6 h intervals according to catch durations (see above) (e.g. Total Catch $=80$; Catch duration $=48 \mathrm{~h}$; number of based 6 h intervals $=8$; catch per 6 h -interval $=$ 10). 6 h catch values were attributed to the corresponding 6 h - wind strength and wind direction data (Table 1). These dataframes were evaluated using wind rose and box-plot diagrams.

Table 3: Example for attributing catch per 6h to averaged (6h) wind directions values depending on identical catch intervals. The last catch interval was calculated by rounding heaving time to next interval limit. Based on this interval prior intervals were determined according to number of catch intervals. The same method was used to attribute catches to wind strength, current direction and current speed values.


## Currents

## Sources of data

Like wind data, current data were obtained from the operational hydrodynamical model of the BSH. Based on the assumption that currents are area specific, two additional stations were included in current analyzes (Table 2). While northern Fehmarn-BSH-station is located next to sampling stations VII-X, these stations are near sampling stations XI and XII-XIII. Unlike wind directions current data were only available in $\mathrm{X}, \mathrm{Y}$ and Z -direction $\left[\mathrm{m} \mathrm{s}^{-1}\right]$.

## Analyses

Data on currents were averaged per 6 h interval. Z -values were not considered, since obtained data belonged to surface, and all Z -values were almost equal to zero. Averaged and untreated current direction values were converted in degrees, using formula 2 and 3.

Formula 3 was applied if the X -value was negative while the Y -value was positive. This was necessary, since otherwise formula 1 had released incorrect achievements.

Formula 2: $\quad$ current direction $\left[{ }^{\circ}\right]=\operatorname{ARCTAN} 2(\mathrm{Y}, \mathrm{X})-\pi / 2$
Formula 3: $\quad$ current direction $\left[{ }^{\circ}\right]=360-\operatorname{ARCTAN} 2(\mathrm{Y}, \mathrm{X})-\pi / 2$
Formula 4: $\quad$ current speed $[\mathrm{m} / \mathrm{s}]=\sqrt{ } \mathrm{X}^{2}+\mathrm{Y}^{2}$

Current speeds were computed using formula 4, based on averaged X - and Y -values.
To analyze the quality of averaged data (especially errors due to averaging of directions), 6h-averaged and untreated values of current directions and current speeds were compared using developing and scatter plots. Additionally, latter plots were used to evaluate differences of currents between areas.

Like wind data, 6 h -average current values were assigned to corresponding 6h-catches (see above; Table 3 ) to assess effects on the catch. Only box plots were used for this evaluation.

## Results

## Catch

A total of 12007 juvenile $\operatorname{cod}(<20 \mathrm{~cm})$ were caught at Funen, 16355 at Lolland and 10660 at Fehmarn (Table 4), whereas Danish samples provided fewer number of sites and shorter sampling periods, higher numbers of juvenile $\operatorname{cod}(<20 \mathrm{~cm})$ were caught compared to Fehmarn. Maximum catches of size class 1 were achieved at Lolland, reaching up to 2000 individuals per 24h (CPUE). These catches occurred at the beginning of the sampling period at all sites of Lolland (Fig 5). Regardless these assumed but well supported outliers, average CPUE of Lolland and Funen were significantly higher than those from Fehmarn. Most small $(<20 \mathrm{~cm})$ and midsize cod $(20-38 \mathrm{~cm})$ from Fehmarn were caught at sites VII and VIII, which are located in northern part of Fehmarn, i.e. in the Fehmarn Belt. In general, the temporal development of CPUE differed by sites (Fig 5). However, when grouping the sites from Lolland (IV-VI) or southern Fehmarn (XII-XIII) there appeared more or less similar patterns of CPUE-development within each group. Beyond this, there seemed to be no trend in catch development.

The analysis of catch-catch duration relationships shows that the number of small cod increases with longer catch durations (Fig 6). Results from Funen and Fehmarn indicate that catch durations longer than 96 h do not provide significant rise of catches This could point at saturation effects or could be caused by poor weather conditions, when nets were not heaved. Moreover, results of linear regression do not support the hypothesis of $1: 1$ relationship (e.g doubled numbers in catch by doubling the catch durations). However, medians of calculated CPUE values (catch per 24h) of all catch durations were almost equal and do not show a trend, especially for Fehmarn data, whereas CPUE-values from Funen and Lolland showed significant higher variations.

The length-weight-relationship for cod is given in Fig 7. The Figure shows that laboratory samples included small size $(<20 \mathrm{~cm})$ as well as midsize $(20-38 \mathrm{~cm}) \operatorname{cod}(88 \% ; 12 \%)$.
Length frequencies for each laboratory sample (Fig 8, left column) show that the fraction of midsized cod ( $20-38 \mathrm{~cm}$ ) increases with time. Additionally, the length distributions show no clear modes or maxima due to low sample sizes. Medians of subsequent samples exhibits no successive increase, although a trend was found. This trend represents mean daily growth (DG) based on the start of the sampling period (Fig 9). DG was used to calculate length frequency distributions at mid-month dates (see above) (Fig 8, right panel).

Table 4: Catches of cod at different size classes and sample sites over the entire sampling period

| site | location | depth | < 20cm (number) | 20-38cm (number) | > 38cm [kg] |
| :---: | :---: | :---: | :---: | :---: | :---: |
| I | Funen | 2 m | 2711 | 386 | 15.5 |
| 11 |  | 3 m | 6578 | 760 | 22.38 |
| III |  | 4 m | 2718 | 405 | 5 |
| Total |  |  | 12007 | 1551 | 42.88 |
| IV | Lolland | 4.5m | 3205 | 600 | 20 |
| V |  | 6 m | 8625 | 1672 | 50 |
| VI |  | 6.5 m | 4525 | 2002 | 53 |
|  | Total |  | 16355 | 4274 | 123 |
| VII | Northern Fehmarn | 4 m | 2390 | 702 | 156 |
| VIII |  | 4 m | 2680 | 590 | 100 |
| IX |  | 4 m | 820 | 393 | 160 |
| X |  | 3.5 m | 866 | 436 | 339 |
| XI | southeastern Fehmarn | 4 m | 1415 | 360 | 139 |
| XII | southern Fehmarn | 3 m | 990 | 208 | 50 |
| XIII |  | 4 m | 1499 | 400 | 154 |
| Total |  |  | 10660 | 3089 | 1098 |



Fig 5: Temporal development of catch per unit effort (24h), shown for every sampling site. Plots from different areas are organized in rows. From top: Funen, Lolland, northern Fehmarn, southeastern Fehmarn, southern Fehmarn. First catches from Lolland exceed the limit of the y-axis. These values are added manually.


Fig 6: Catch-catch duration relationships. Upper panel: Total catch of juvenile cod; lower panel: CPUE of juvenile cod. Catches with a longer catch duration than 120 h occurred in maximum once per location and are not shown.


Fig 7: Length-weight relationship of cod caught at Fehmarn, from samples brought to the laboratory


Fig 8: Length frequency distribution for juvenile cod caught at Fehmarn. left column: length frequency distributions for each date were laboratory-samples were taken; right column: length frequency distributions estimated for the middle of each month. The median is indicated by dotted red lines.


Fig 9: Mean daily growth $(D G)$ of cod (only Fehmarn samples). Estimates are based on the median of length distributions of each sample. Blue lines indicate the confidence interval.

## Abiotic data

## Temperature

With regard to temperature data, both water and air temperature decreased from the beginning to the end of the sampling period (Fig 10). Both data series show cold snaps and upswings, whereas negative air temperature and water temperature deviations from trend were more intensively then the reverse, reaching to -3.8 and $-1.8^{\circ} \mathrm{C}$, respectively (Fig 10). However, 42 and accordingly 45 percent of days within sampling period (1.Sept to 6.Dec 2008) were below the water and air temperature trend. Medians of small cod CPUE were higher by positive deviations from temperature trend (DTT), for both water and air temperature (Fig 12).


Fig 10: Air temperature, water temperature and deviation from trend from 11.Sept to 6.Dec 2008

Temperature dependent absolute and relative growth of subsequent mid-month dates show no significant trends (Fig 11). Growth between the intervals October-November and November-December were almost equal (absolute growth: 6.19 cm and 6.13 cm ; relative growth: 0.035 and 0.033 ). However, the growth decreases strongly from September to October (absolute growth: 14.46; relative growth: 0.086). Hawkins et al. (1985) characterized specific growth of juvenile demersal cod from the western Scottish coast. Our results of specific growth values (Sept-Oct: 0.288; Oct-Nov: 0.112; Nov-Dec: 0.111 ) were within range mentioned in their study( $0.0-0.6$ ).


Fig 11: Temperature dependent absolute (black squares) and percentage growth (green points)


Fig 12: DTT-catch relationship; Deviations from water and air temperature trend (DTT) and catch of small cod (CPUE). Left: raw data; Right: corresponding data grouped by direction of deviation from trend.

Wind
Wind directions from northern Fehmarn obtained from BSH (Table 2) are comparable with data obtained from wetteronline.de (Fig 13). Furthermore, averaged wind direction values mostly appeared to be located in the range of raw values ( Fig 14A-C).

All locations show more or less similar patterns concerning wind direction and strength ( Fig 14A-C). Wind directions at all sites were dominated by southwestern and northeastern winds during the sampling periods (Fig 15). Wind strength roses of Lolland and Fehmarn appeared to be quite similar, whereas results from Funen are restricted by the limited sampling period. Wind forces occurred independently from wind direction. However, at Lolland and Fehmarn low wind speeds were more frequent by southerly winds.

Catches from Funen appeared to be less abundant at eastern and southeastern winds (Fig 16 \& 17). However, due to the short sampling period, information at several wind directions are not available. This applies also to data from Lolland, where low catches occurred especially at northwesterly and northeasterly winds. Data from Fehmarn represent the longest sampling period and accordingly most wind directions are covered. Here, southwestern winds $\left(45^{\circ}\right)$ seem to result in low catches, regardless which station is considered. Otherwise, westerly winds appeared to result in higher catches at northern and southeastern Fehmarn. In summary, close relationships of catches to wind directions were not quite evident due to high variability at higher catches.

As a result, wind strength data provide less evidence concerning direct effects on catches. Uniform patterns were not apparent (Fig 18).


Fig 13: Comparison of 6 h average data from BSH (station Fehmarn) and wetteronline.de



Fig 14: Wind direction, wind speed and wind force at Funen (A), Lolland (B) and Fehmarn © over time. Averaged data in green. Grey frame indicates the sampling period in that area. Positions of stations in Table 1.


Fig 15: Upper panel: Wind roses for sampling areas indicating the occurrence of all wind directions (intervalls: $10^{\circ}$ ); lower panel: wind-strength roses for each sampling area indicating the proportion of different windspeed (in bft) at specific wind directions.


Fig 16: wind-catch roses for each station (proportion of groups of numbers of small cod at given wind direction). Due to different directions of coastlines at sampling stations of Fehmarn, subareas with similar conditions were analyzed separately. Gaps in graphics are caused by less or missing wind directions during sampling periods.


Fig 17: Wind direction-catch relationship. 6h-interval degrees are rounded to one decade.




Fig 18: Wind-force catch relationship. Outliers greater 50 are not illustrated for sites of Lolland.

## Currents

All stations have shown quite similar patterns concerning current directions and speeds (Fig 19, left panels). Since variability was low, current directions could be separated into two groups, regardless the locations. The second direction was always the approximate opposite direction $\left(+/-180^{\circ}\right)$ of the first one. However, directions differed from location to location. Main direction groups for each location and their frequencies within the sampling period are given in Table 5. Both directions were constant over several hours. However, current directions often alternated several times per day and one direction group was often more frequent than its counterpart. Current direction-catch relationships for all locations are illustrated in Fig 20.

Table 5: Frequencies for treated and untreated data of current main direction groups at different locations during the maximum sampling period of each location (Table 1).

| Iocation | Funen |  | Lolland |  | northen Fehmarn |  | southeastern Fehmarn | southern Fehmarn |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| direction group [ ${ }^{\circ}$ ] | $160-170$ | $340-350$ | $160-180$ | $340-360$ | $90-100$ | $270-290$ | $80-100$ | $260-280$ |
| untreated data (15min value) | $38.0 \%$ | $59.5 \%$ | $52.2 \%$ | $44.8 \%$ | $44.3 \%$ | $55.7 \%$ | $63.2 \%$ | $28.1 \%$ |
| treated data (6h average) | $39.1 \%$ | $59.5 \%$ | $54.1 \%$ | $44.4 \%$ | $34.1 \%$ | $44.7 \%$ | $59.2 \%$ | $31.8 \%$ |

In most cases high current speeds occurred only within these two groups of current directions, showing typical peaks (Fig 19, right panels). Current speed-catch relationships are given in Fig 21. CPUEmedians increased with increasing current speeds at Funen, Lolland and northern Fehmarn, although catches from northern Fehmarn decreased by exceeding a current speed of $0.25 \mathrm{~m} / \mathrm{s}$. Current speeds from southern and southeastern Fehmarn have not shown clear trends.


Fig 19: Developing of current direction and current direction-speed relationship. 6h averaged values are illustrated as green points. Grey frames indicate the sampling periods at the specific locations.


Fig 20: Current direction-catch relationship. 6 -interval directions are rounded to one decade ( $10^{\circ}$ intervals). Missing box plots indicate missing current directions.


Fig 21: Current speed-catch relationship. Missing box plots indicate missing current speeds. Outliers greater 50 are not illustrated for sites of Lolland.

## Discussion

In this study, we have investigated catch data of cod 0 -group in the western Baltic Sea, which are collected by self-sampling of fishermen in Denmark and Germany. These catches were conducted using pound nets along the coast of the Islands of Funen, Lolland and Fehmarn. The aim of this study was to

- investigate temporal and spatial patterns of these catches
- investigate the influence of abiotic factors on these catches
- present a way to estimate a recruitment (0-group) index for western Baltic cod based on the investigations mentioned above

The catch per unit effort (CPUE in numbers per 24h) differed by site (i.e. pound net) and location (Funen, Lolland and Fehmarn), although some adjacent sites have shown a similar range of CPUE. The catches from Lolland and Funen exceeded those from Fehmarn by the factor 3-10. Therefore, it can be assumed that habitat utilization for these areas differed. Gregory et al. (2003) described an increase in recently settled cod abundance with simulated eelgrass and a corresponding decrease in sites where eelgrass has been removed. Borg et al.(1997) pointed out, that during daytime habitat choice of young and large juvenile cod is correlated to vegetation types, while both groups preferred Fucus vesiculosus significantly. Hence, further informations concerning habitat structure are necessary. In many studies different behavior of juvenile cod was observed during day and night (Grant and Brown 1998), Methven and Schneider 2004, Borg et al. 1997). However these behavior patterns are connected to locations, age and predation pressure (Kamenos et al. 2004). Since different behavior during day and night would biased averaging catch data into 6h intervals, knowledge about differences in day and night time behavior (and consequently catch rates) is necessary, but not available for the area of investigation.

The temporal development of CPUE of small cod has not shown a clear trend, regardless which site is considered (Fig 5).

Catch increased significantly with longer catch duration, although a 1:1-relation was not found (i.e. doubled total catch was not achieved by doubling catch durations. Bogstad et al. (1994) stated that cod feeds large numbers of their own species, especially those of age $0-2$ and reported furthermore intercohort cannibalism between 1- to 3- year old cod. Therefore, one possible explanation could be that reduced CPUE of small cod is caused by cannibalism and predation by other species within the
pound net. Reducing catch durations or disregarding of long catch duartions in further analyes should be made to minimize these sources of errors. If this is not possible, diet analyses of midsize $(20-38 \mathrm{~cm})$ and sized $\operatorname{cod}(>38 \mathrm{~cm})$ should be undertaken to evaluate this potential affect. Longer catch durations caused by periods of bad weather resulting in lower catches could be a second explanation.
Fishermen were asked to take a sample of cod from size group $1(<20 \mathrm{~cm})$ for later analysis in the laboratory. Length frequencies of laboratory samples show that the later the season, the more cod from size group $2(20-38 \mathrm{~cm})$ were taken in the samples (due to growth of the cohort). This reveals that a) the range of size groups used for the protocols may not be optimal and do not cover the entire length spektrum over the entire season and b) that numbers per size group given in the protocols do not strictly refer to the predefined size groups. Moreover, fishermen seemed to adapt these size groups to the actual size range of the cohort. To encompass the entire cohort of 0-group cod, it is advisable to extent the size limit of small cod to 25 cm . The separation of 0 -group and (small individuals) of age 1 cod in this extended size group $1(<25 \mathrm{~cm})$ has to be done using otolith age readings.
By averaging wind direction data in 6 h intervals daily variations were covered more broadly and arithmetic errors concerning the averaging method of wind direction were reduced. However, these errors still exist since no method was found, which provides a suitable solution. The comparison of 6 h average data from BSH with data from wetteronline.de using linear regression showed significant relation ( $\mathrm{r}^{2}=0.66$ ), but suffered from the same problem, not recognizing similarities of high and less degrees (e.g. $350^{\circ}$ and $0^{\circ}$ ). Hence correlation is suggested to be even higher. Similar values and development of wind data at different areas indicate that wind directions and strength are relative constant over greater distances. Therefore, using only one source of wind data for each sampling location can be assumed to provide suitable and authentic values.

Wind directions and strength are known to affect distribution of eggs and larval stages of fish (Margoñski 2000, Hinrichsen et al. 2008). Furthermore, Nanami \& Endo (2007) have shown that occurrence of adult fish of various species within the surf zone is addicted to wind condition. However, our results indicate effects, though they are less well-defined. Especially wind directions seem to affect catches, whereas catches did not show close correlation to wind strength. Although, wind directions are superimposed by wind strength data and therefore wind strengths might influence wind direction effects on catches. Multiple correlation analyses could improve the understanding of relationships. Such investigations were made by Gibson et al. (1993) They developed a "wind factor", which combines wind directions and wind strengths and relate them to the compass directions of the beach.

As wind conditions, currents can be assumed to affect fish occurrence, particularly since wind can causes currents. Within our study area currents occurred mainly in two groups of directions. Differences concerning effects on catches of both groups were low. Therefore current directions apparently did not impact catches.
Increasing current speeds were attended by increasing catches. However, strong currents ( $>0.3 \mathrm{~m} / \mathrm{s}$ ) were accompanied by low catches. Shore structures influence current speeds and directions. Taking one current station to analyze catches of various sampling stations could distort results.

## Estimating abundance index of 0-group cod

In the recent assessment of western Baltic cod (ICES 2008), three tuning fleets are used for Baltic cod recruitment estimates (Table 6). These tuning fleets have a poor performance concerning youngest age group (Fig 22). It is assumed, that the surveys do not cover the spatial distribution of 0 -group cod appropriately.

Table 6: Tuning fleets of Baltic cod stock assessment (ICES, 2008)

| Fleet | Year range | Age range |
| :--- | :--- | :--- |
| "Solea", Q4, SD22-24 | 1994-present | age 1-3 |
| Danish Gilnetters | 1994-present | age 2-6 |
| Danish Trawlers | 1992-present | age 3-6 |
| "Havfisken", Q1, SD22-23 | 1995-present | age 1-3 |
| "Havfisken", Q4, SD22-23 | 1994-present | age 1-3 |



Fig 22: The present correlation between the 0 group from the two scientific surveys and the outcome of age 1 (back shifted) from the assessment. data from ICES(2008); graphic delivered from M. Storr-Paulsen.

Based on our results we present an algorithm to calculate a recruitment index to be used as tuning fleet for the assessment of the western Baltic cod or directly in short term forecast. Though it would be possible to use this index in addition to the already existing young cod index from "Solea" and "Havfisken" or as a separate index. However, we accentuate that this data series was founded in 2008 and utilization for index calclaution is not possible until the time series has a duration of about 5 years. Therefore, the algorithm presented is preliminary and has to be checked and adapted if more data are available (e.g. if variation estimates are available).
For the establishment we took the following considerations into account:

The new data series and hence the recruitment index should meet following requirements:

1. the data series should have a long term perspective
2. the data series should be resistant, concerning changes of the spatial distribution of 0 -group western Baltic cod

## Therefore:

a) we advise to record three different time series of pound net fishery, one for each location (Funen, Lolland, Fehmarn)
b) it is necessary to gather samples at as much sites per location as possible
3. the size range of 0 -group has to be covered totally

Therefore: size limit of size class I (small cod) should be expanded to 25 cm
4. the sample size for laboratory analyzes has to be raised to at least 100 individuals or 5 kg per sample, to achieve represent samples (i.e. appropriate length distributions)

Calculation of the indicator:

1. The number of cod in size group $1(<25 \mathrm{~cm})$ potentially include specimen from age group 0 and age group 1. To gather the true number of 0 -group cod caught in pound nets, a correction is necessary. The proportion of 0 -group cod has to be investigated from otolith readings of laboratory samples.

Equation 1: $\quad \mathrm{CPUE}_{0 \text {-group }}=\mathrm{CPUE}_{\text {sample }} * \mathrm{P}_{0 \text {-group }}$
whereby CPUE $_{0 \text {-group }}$ is the number of cod of age group 0 per fishing activity; CPUE $_{\text {sample }}$ is the number of cod in size group 1 , recorded by fishermen; $\mathrm{P}_{0 \text {-group }}$ is the proportion of small cod in laboratory sample which corresponds to area and date of CPUE sample
2. The corrected CPUE $_{0 \text {-group }}$ of all sites per location (Lolland, Funen and Fehmarn) should be averaged for the entire season, resulting in mean location CPUE ( $\mathrm{CPUE}_{\text {loc }}$ )

Equation 2: $\quad \operatorname{CPUE}_{\text {loc }}=\left(\mathrm{SPUE}_{0-\text {-group,loc }}\right) / \mathrm{n}_{\mathrm{i}, \mathrm{loc}}$
whereby CPUE $_{0 \text {-group,loc }}$ is the number of cod of age group 0 of fishing activity at location loc; $n_{i, \text { loc }}$ is the number of recorded catches at location loc
3. For all three locations (Lolland, Funen and Fehmarn), an index (index ${ }_{\text {loc }}$ ) will be calculated

Equation 3: $\quad$ meanCPUE ${ }_{\mathrm{loc}}=\left(\mathrm{CPUE}_{\mathrm{loc}, \text { years }}\right) / \mathrm{n}_{\mathrm{loc}, \text { years }}$
whereby meanCPUE ${ }_{\text {loc }}$ is the mean of $\mathrm{CPUE}_{\mathrm{loc}}$ of all years at this location $\left(\mathrm{CPUE}_{\mathrm{loc}, \text { years }}\right)$ and $n_{\mathrm{loc}, \text { years }}$ is the count of years for which $\mathrm{CPUE}_{\mathrm{loc}}$ are available at this location

Equation 4: $\quad$ index $_{\text {loc }}=\left(\mathrm{CPUE}_{\text {loc }} /\right.$ meanCPUE $\left._{\text {loc }}\right) \quad-1$
example:

| CPUE $_{\text {loc }}$ | meanCPUE $_{\text {loc }}$ | index $_{\text {loc }}$ |
| :--- | :--- | :--- |
| 20 | 20 | 0 |
| 10 | 20 | -0.5 |
| 30 | 20 | 0,5 |

4. An overall index for a given year (index) will be calculated

Equation 5: $\quad$ index $=\left(\right.$ index $\left._{\text {loc }}\right) / \mathrm{n}_{\mathrm{loc}}$
whereby index ${ }_{\text {loc }}$ are the indices for every location (which is available for this year) and $\mathrm{n}_{\mathrm{loc}}$ the number of location for which an an index is available for this year.

## Recommendation

The Sampling design should be revised in several aspects. Protocols must be completed uniformly. Uniform records and sampling periods are necessary to analyze catches of different study areas. Furthermore sampling periods should start earlier and catch durations should be reduced. Diet analyzes are necessary to study the impact of cannibalism on catches. To estimate growth extensive samples of juvenile cod are needed. Length-frequency analysis show that classifying cod length by fishermen is deficient. Therefore this error must be determined by using length frequency analysis. Although, it is important to consider the fraction of juvenile $\operatorname{cod}(<20 \mathrm{~cm})$ in midsize catch data as well. Laboratory samples of juvenile and midsize cod of each fishermen are necessary to evaluate length class error.

## Acknowledgements

I grateful, thank fishermen, C. Fröse from Fehmarn, K. Hansen from Funen and J. Rasmussen from Lolland. Special thanks to C. Fröse, his father and his son for participation on a drive. Additional thanks to H. Komo and D. Schrader who provided BSH-data and further informations.
This work was undertaken with the support from the Institute of Baltic Fisheries (vTi-OSF) and the National Institute of Aquatic Resources (DTU-Aqua). Special thanks to M. Storr-Paulsen, D. Stepputtis, C. Hammer and R. Weigelt whose help, especially comments and ideas facilitated and improved this manuscript. I particularly acknowledge B. Stepputtis, Marianna Wolfram and the Danish technicians for their laboratory work.

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## Appendix 1

| Pound net - haul form | Ship: | Captain: | Ship code: | Filled in from: |
| :---: | :---: | :---: | :---: | :--- |


| Position | Latitude | Longitude | Water depth |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | ${ }^{\circ} \quad \mathrm{N}$ | ${ }^{\circ} \quad, \mathrm{E}$ | m |


| Haul- | Date | Time (Start) | Time (End) | Wind |  | Weather | $\mathbf{C o d}<20 \mathrm{~cm}$ |  | Cod 20-38 cm |  | Cod (sized) |  | Comment (e.g. Discard, Specials, Frost sample, etc....) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | (dd/mm/yy) | (hh:mm) | (hh:mm) | Direction | Force | Code | Number (p.) | Weigth (kg) | Number (p.) | Weigth (kg) | $\begin{gathered} \text { Landing } \\ (\mathrm{kg}) \end{gathered}$ | $\begin{aligned} & \square \mathrm{vmK} \\ & \square \mathrm{amK} \end{aligned}$ |  |
| 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2 |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3 |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4 |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 5 |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 6 |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 7 |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 8 |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 9 |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 10 |  |  |  |  |  |  |  |  |  |  |  |  |  |

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Fig 23: Pound net haul protocol

| windforce | wind speed |  |  |  | wave height (m) |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| in bft | $\mathrm{m} / \mathrm{s}$ | $\mathrm{km} / \mathrm{h}$ | mph | kn | deep sea <br> (Atlantic) | shallow sea (North and Baltic Sea) |
| 0 | 0,0-<0,3 | 0 | 0-<1,2 | 0-<1 | - |  |
| 1 | 0,3-<1,6 | 1-5 | 1,2-<4,6 | 1-<4 | 0,0-0,2 | 0.05 |
| 2 | 1,6-<3,4 | 6-11 | 4,6-<8,1 | 4-<7 | 0,5-0,75 | 0.6 |
| 3 | 3,4-<5,5 | 12-19 | 8,1-<12,7 | 7-<11 |  |  |
| 4 | 5,5-<8,0 | 20-28 | 12,7-<18,4 | 11-<16 | 0,8-1,2 | 1 |
| 5 | 8,0-<10,8 | 29-38 | 18,4-<25,3 | 16-<22 | 1,2-2,0 | 1.5 |
| 6 | 10,8 - <13,9 | 39-49 | 25,3-<32,2 | $22-<28$ | 2,0-3,5 | 2.3 |
| 6 | 13,9 - <17,2 | 50-61 | 32,2-<39,1 | $28-<34$ | 3,5-6,0 | 3 |
| 8 | 17,2-<20,8 | 62-74 | 39,1-<47,2 | 34-<41 | $\begin{array}{r} \hline \text { more than } \\ 6,0 \end{array}$ | 4 |
| 9 | 20,8-<24,5 | 75-88 | 47,2-<55,2 | 41-<48 |  |  |
| 10 | 24,5-<28,5 | 89-102 | 55,2-<64,4 | 48-<56 | till 20,0 | 5.5 |
| 11 | 28,5-<32,7 | 103-117 | 64,4-<73,6 | $56-<64$ | more than |  |
| 12 | >32,7 | >118 | >73,6 | >64 | 20,0 | $-$ |


| weather |  |
| :--- | :--- |
| 0 | clear, cloudless |
| 1 | partial cloudy |
| 2 | closed cloud cover |
| 3 | sand-, dust- or snow storm |
| 4 | fog or heavy smoke |
| 5 | drizzel |
| 6 | rain |
| 7 | sleet or snow |
| 8 | show er |
| 9 | no notice |

## fishing gear type

| OTB | Otter Traw I Bottom |
| :--- | :--- |
| PTB | Pair Traw I Bottom |
| TTB | Tw in Traw I Bottom |
| OTM | Otter Traw I Midw ater |
| PTM | Pair-Traw I Midw ater |
| GNS | Gill Net Set |
| GND | Gill Net Drift |
| LLS | Longline Set |
| FPN | Uncovered Pound Net |
| FYK | Fyke Net |
| FPO | Fish Pot |

Fig 24: Explanatory notes to pound net haul protocol for fishermen

## Appendix 2

Table 7: Sampling periods and catch durations for each sites. Periods are colored, catch durations are given in hours at heaving days. Dates of laboratory sampling are illustrated in the outermost column. Question marks indicate samplings with unknown catch durations (those catches are not used in the analyses).


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