JRC Scientific and Technical Reports

Scientific, Technical and Economic Committee for Fisheries (STECF)

Impact Assessment of Baltic cod multi-annual plans (STECF 11-05)

Edited by John Simmonds

This report was reviewed by the STECF during its 37th plenary meeting held from 11 to 25 July, 2011 in Copenhagen, Denmark.

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The Scientific, Technical and Economic Committee for Fisheries (STECF) has been established by the European Commission. The STECF is being consulted at regular intervals on matters pertaining to the conservation and management of living aquatic resources, including biological, economic, environmental, social and technical considerations.

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SCIENTIFIC, TECHNICAL AND ECONOMIC COMMITTEE FOR FISHERIES (STECF)

Impact Assessment of Baltic cod multi-annual plans (STECF-11-05)

This report was adopted by the STECF during its 37th plenary meeting held from 11 to 15 July, 2011 in Copenhagen, Denmark.

Request to the STECF

STECF is requested to review the report of the **EWG-11-07** held from June 20 – 24, 2011 in Hamburg, Germany evaluate the findings and make any appropriate comments and recommendations.

Introduction

A joint ICES / STECF meeting was held in Hamburg 20-24 June 2011, to prepare impact assessments for Southern hake, Nephrops and Angler fish and Baltic cod and an Evaluation of existing plans for Kattegat, North Sea, West of Scotland and Irish Sea cod. The meeting involved STECF, ICES scientists dealing with Economy and Biology and included Observers (Commission staff, Managers, Stakeholders). Three separate reports to the STECF were prepared by the EWG-11-07, one on the Impact Assessment of Southern hake, Nephrops and Angler fish (STECF 11-06) and another on the Impact Assessments for Baltic cod (STECF 11-05)and the third on the Evaluation of Cod in Kattegat, North Sea, West of Scotland and Irish Sea (STECF 11-07). All reports were reviewed by the STECF during its 37th plenary meeting held from 11 to 15 July 2011 in Copenhagen, Denmark. The following observations, conclusions and recommendations represent the outcomes of that review for Baltic cod report.

STECF observations

STECF commends the EWG-11-07 for its hard work with the Impact Assessment of fisheries on Baltic cod and the report provided. STECF understands that the Commission is currently considering combing the management of Baltic cod with that for pelagic species, to create a multispecies plan for the Baltic. In this context STECF note that this evaluation provides advice on single species exploitation for cod in the Baltic. The conclusions might be different if exploitation on cod is combined with targets for other species.

STECF conclusions

STECF draws a number of conclusions for consideration when developing plans for cod fisheries in the Baltic.

Objectives and targets:

The following considerations are based on the assumption that the objectives of a Baltic cod management plan are to ensure exploitation of the cod stocks provides sustainable economic, environmental and social conditions and the aim is to restore and maintain the stocks at or above levels which can produce maximum sustainable yields not later than 2015.

The STECF considers that within the historical stock sizes exploitation of the two cod stocks at target fishing mortalities of 0.33 is consistent with the objective of MSY. If the stock sizes increase to a state where it influences the population parameters (eg. growth or maturation change due to stock size) it may be necessary to adapt the target fishing mortalities to obtain MSY.

Discards are included in the F_{MSY} evaluations and a possible discard ban is unlikely to affect the conclusions on MSY targets unless a ban will result in a major change in the exploitation pattern.

A higher MSY could potentially be obtained for Eastern Baltic cod by changing size selection towards harvesting cod >70 to77cm.

Tactical approaches

STECF recommends that management plans should be developed with a range of potential tools available to manage the fisheries. Past experiences show that it is important that a management plan includes options for actions to be taken in case the TACs are shown to be ineffective in limiting fishing mortalities. Managers should choose a minimum set of control measures that are thought to be appropriate at the time, but should retain the ability to relax or deploy additional tactical methods (eg. TACs, Effort controls, technical measures) should the plan be failing to deliver its objectives.

Management through limitation of catches

The current enforcement of the TACs appears to be sufficient to control the total outtake. Discards have been relative limited and stable in recent years and the EWG concludes that the currently TACs have been effective in limiting fishing mortalities.

F target based harvest control rules with catch calculated using a short term forecast and a percentage constraint on inter-annual change in TAC are considered appropriate in defining the TACs for both stocks. However, the simulations presented in section 7 indicate that a 15% constraint on inter-annual variation in the TACs is not required to achieve the biological objectives.

Although discards appear at present not to be a problem in relation to limiting fishing mortality, a management plan should include explicit rules for addressing discards. This could be implemented by defining the TAC as total allowable catch and by ensuring that all catches (landings as well as discards) are counted against the TAC.

Recreational catches constitute, in certain areas, a measurable and variable part of the total catches and to ensure a proper limitation of total catches, catches of cod in the recreational fisheries should be addressed in the management plan.

Limitation of fishing effort

The evaluation of the present multiannual management plan, and the simulations presented in section 7, indicate that rules for effort limitations are not currently required to meet the biological objectives, as long as the limitations in catches are effective in limiting the fishing mortality as intended.

Spawning closures

The impact on the present spawning closures on the stocks and the fisheries is unclear but the measures are unlikely to have had a limiting effect on the overall fishing mortality and EWG concludes that spawning closures are not required to meet the biological objectives as long as the TACs effective in limiting the fishing mortalities as intended.

If spawning closures are included in a future management plan it is recommended that it is ensured that the timing of the closures matches the spawning periods of the spawning components to be protected.

Other measures (gear rules, MLS, etc)

A number of technical measures including gear rules, minimum landing size and maximum by-catch percentages currently included in the technical measures regulation affect the fisheries on the cod stocks. These measures have little impact on the overall fishing mortality and are not required to meet the biological objectives as long as the limitations in catches is effective in limiting the fishing mortality as intended.

The measures may, however, have had a positive impact on the exploitation pattern on cod and as such a positive impact on the yield per recruit.

Economic impacts

The 15% rule was introduced for economic reasons. Its intention is to limit the additional supply of Baltic cod on the market to stabilize prices. However, in practice prices decreased sufficiently so that even with a higher TAC revenues declined. The decrease in price has been partly attributed to campaigns which criticised cod for being unsustainably exploited, while substitutes (e.g. pangasius) were being declared sustainable. However the main influence was made by deterioration of economic situation and general reduction of consumption affected by recent economic crisis. For 2011 the situation seems to stabilize.

The economic simulations were run by using the bio-economic model framework FLR instead of running the FishRent model as discussed at the scoping meeting. With a 10-year simulation a baseline scenario and several options for future management were assessed. The differences regarding future profits between the baseline (±15% TAC constraint) and ±30% TAC constraint, regulating only F (0.6) without effort constraints, only effort constrains without TACs and a discard ban with a 10% TAC compensation are insignificant or very small. However, as stated in the report, these results have to be treated with caution as the small differences may be due to the design of the simulation.

The conclusion in Ch. 9.3 is that it is economically viable to increase the size of cod in the catches which will lead to a faster recovery of the stock. However, the assumption that larger cod lead to higher revenues relies only on information on a small fraction of the catch in Sweden. There are indications that processors prefer smaller cod. Moreover, the problem of such an approach is that there will always be higher losses at the beginning and higher revenues after several years compared to the actual management plan. The transition phase is, therefore, more demanding for the fishing sector and so far similar proposals (e.g. Döring & Egelkraut 2008) were never implemented as no one wanted to cover the higher transition costs.

STECF recommendations

If MS and the Commission wish to request STECF to advise on a multispecies plan for the Baltic, such a plan will require a scoping meeting. In order for scientific advice to be given, Commission and MS need to indicate in that meeting a range of aspects. STECF suggests the following aspects should be included in the Terms of Reference of the scoping meeting

An EWG to define the needs for an Impact Assessment of a multispecies plan for the Baltic is requested to organise a meeting the following tasks:

- Commission and MSs should identify which fisheries are to be included; any specific social-economic objectives for the fisheries; any specific objectives in terms of relative stock biomass between the species included in the plan, single stock size structure and general target fishing mortality objectives, with a time frame for required changes in stock size and exploitation status.
- Commission and MSs should identify where possible the priority for multiple objectives i.e. among single species and socio-economical objectives or those aspects where tradeoffs need to be illustrated.
- Commission and MSs should identify the regulatory measures (eg. catch quotas) that are most likely to be implemented to reach the objectives of the plan.
- For these regulatory measures the expected potential implementation success should be estimated.
- Scientists should identify data currently available to parameterise species interaction in the Baltic. In particular, data required to determine the dependence of recruitment, natural mortality and growth of each species on the abundance and distribution of the other species considered in the plan, including any knowledge on the temporal stability of these effects. Also, the data required to assess the existence and magnitude of any within species density dependence of recruitment, natural mortality and growth, including any knowledge on the temporal stability of these effects.
- Economists should identify socio-economic data available to evaluate the socio-economic aspects of different management strategy and objectives.
- Scientists/economists should describe modelling frameworks already developed to analyse multispecies interactions and evaluate multispecies objectives. Illustrate and review the results already obtained by multi-species modelling already in use in the Baltic. Indicate their current utility and identify any advances required.
- Identify any critical gaps in knowledge or modelling that might affect the utility of the analyses described above.
- Determine any data collection/collation required and the timescale for deliver.
- Propose the modelling framework(s) to be utilised for the evaluation and list:
    1. the basis for parameterisation
    2. the run options to be evaluated
    3. the metrics to be presented

REPORT TO THE STECF

EXPERT WORKING GROUP ON MULTI-ANNUAL PLANS IMPACT ASSESSMENT FOR BALTIC COD (STECF-11-05)

Hamburg, Germany. 20-24 June 2011

1. EXECUTIVE SUMMARY

A joint ICES / STECF meeting was held in Hamburg 20-24 June 2011, to prepare an Impact Assessment for Baltic cod. The meeting involved STECF, ICES scientists dealing with Economy and Biology and included Observers (Commission staff, Managers, Stakeholders). Three separate reports to the STECF were prepared by the EWG-11-07, one on the Impact Assessment of Southern hake, Nephrops and Angler fish and another on the Impact Assessments for Baltic cod and the third on the Evaluation of Cod in Kattegat, North Sea, West of Scotland and Irish Sea.

The EWG drew a number of conclusions for consideration when developing plans for cod fisheries in the Baltic

Objectives and targets: Based on the assumption that the objectives of a Baltic cod management plan are to ensure exploitation of the cod stocks that provides sustainable economic, environmental and social conditions *to maintain* the stocks at or above levels which can produce maximum sustainable yields not later than 2015. The WG considers that based on single species considerations the two cod stocks at target fishing mortalities of 0.33 is consistent with the objective of MSY, and that high yields and low risk to the stock size can be obtained with fishing mortalities between 0.2 and 0.5 (ages 4-7 for eastern area and ages 3-6 western area). If the stock sizes increase to a state where it influences the population parameters it may be necessary to adapt the target fishing mortalities to obtain MSY. A higher MSY could potentially be obtained for Eastern Baltic cod by changing size selection towards harvesting cod >70 to77cm.

Limitation of catches: The current enforcement of the TACs appears to be sufficient to control the total outtake. Discards have been relative limited and stable in recent years and the EWG concludes that the TACs have been effective in limiting fishing mortalities. However, it is important that a management plan includes options for actions to be taken in case the TACs are shown to be ineffective in limiting fishing mortalities. Although discards appear at present not to be a problem in relation to limiting fishing mortality, a management plan should include explicit rules for addressing discards.

Recreational catches constitute, in certain areas, a measurable and variable part of the total catches and to ensure a proper limitation of total catches, catches of cod in the recreational fisheries should be addressed in the management plan.

Limitation of fishing effort: The evaluation indicates that rules for effort limitations are not required to meet the biological objectives as long as the limitations in catches is effective in limiting the fishing mortality as intended. However, it might be useful to include options in a management plan allowing for limitations of the fishing effort in case the TACs prove not to be effective in limiting the fishing mortalities as intended.

Spawning closures: The impact on the present spawning closures on the stocks and the fisheries is unclear but the measures are unlikely to have had a limiting effect on the overall fishing mortality and EWG concludes that spawning closures are not required to meet the biological objectives as long as the TACs effective in limiting the fishing mortalities as intended. If spawning closures are included the timing of the closures should better match spawning season.

Other measures (gear rules, MLS, etc): A number of technical measures including gear rules, minimum landing size and maximum by-catch percentages currently included in the technical measures regulation affect the fisheries on the cod stocks. These measures have little impact on the overall fishing mortality and are not required to meet the biological objectives as long as the limitations in catches is effective in limiting the fishing mortality as intended. The measures may, however, have had a positive impact on the exploitation pattern on cod and as such a positive impact on the yield per recruit.

2. Conclusions of the Working Group

The Workshop draws the following general conclusions regarding the development of multi-annual management plans for cod in the Baltic.

Objectives and targets:

The following considerations are based on the assumption that the objectives of a Baltic cod management plan are to ensure exploitation of the cod stocks that provides sustainable economic, environmental and social conditions and the aim is to restore and maintain the stocks at or above levels which can produce maximum sustainable yields not later than 2015.

The EWG considers that within the historical stock sizes exploitation of the two cod stocks at target fishing mortalities of 0.33 is consistent with the objective of MSY. If the stock sizes increase to a state where it influences the population parameters it may be necessary to adapt the target fishing mortalities to obtain MSY.

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The measures may, however, have had a positive impact on the exploitation pattern on cod and as such a positive impact on the yield per recruit.

3. RECOMMENDATIONS OF THE WORKING GROUP

If MS and the Commission wish to request STECF to advise on a multispecies plan for the Baltic. Such a plan will require a scoping meeting. In order for scientific advice to be given, Commission and MS need to indicate in that meeting a range of aspects:

- Confirm the regulatory measures are most likely to implement, and specifically those they are not willing to consider, focusing available expertise in the most productive areas.
- Specific objectives with timescales for any changes in stock or exploitation status,
- If there are multiple objectives i.e. the individual species objectives.
- Some idea of the tradeoffs that would be of interest, in tomes of yield from species of different value fished by different fleets.
- If catch quotas are to considered for some fleets, those with expertise in compliance should be requested to attend to discuss compliance for catch quotas, likely errors and uncertainties.

For the scientific studies to be determined a number of aspects should be brought for discussion to the scoping meeting:-

- Information on the datasets available to parameterise species interaction in the Baltic.
- Information on the year on year and across regime stability in multispecies interaction in the Baltic
- Suitable modelling frames already developed to evaluate multispecies targets and tradeoffs.

- Information on the dependence of single species population metrics such as recruitment, natural mortality and growth on abundance and distribution of other species and stock size and any within species density dependence.
- Single species models to evaluate short term variability in exploitation.

Evaluation of any future plans should be set not earlier than after 5 years of implementation, because before this time too little information will be available to allow for both biological and economic reviews.

4. INTRODUCTION

EWG 11-07 met in Hamburg 20-24 June 2011, The WG was organised with STECF members, and invited experts, and observers from Baltic NS, NWW and SWW RACs, and managers from some MS.

4.1. Terms of Reference for EWG-11-07

The Workshop on Management plans Pt 2 (ICES - WKMPROUNDMP2011 STECF – EWG 11-07) Chaired by John Simmonds, Italy, will meet at VTI, Hamburg, Germany 20–24 June 2011 to:

1. provide Impact Assessment reports (2 reports) for
    - Baltic Cod
    - Southern hake, anglerfish and Nephrops
2. provide a combined Evaluation report on cod plans for the following areas:
    - Kattegat
    - North Sea
    - West of Scotland
    - Irish Sea
3. provide a Clarification on NS whiting advice

WKMPROUND2001/EWG 11-07 will provide a complete draft report by 1 July to the attention of the STECF and ACOM and a final draft by 6 July.

Procedures and work will follow the work plan specified in the ICES STECF report WKMPROUND2001 EWG11-01, March 2011 for cod plans and the ad hoc meeting 29-30 March, Brussels for Southern hake anglerfish and Nephrops.

4.2. Agenda

The approach to the meeting was to hold discussions on each TOR separately in order to allow observers to manage their attendance

Monday 20 June Open the meeting 1400
Report requirements, Section responsibilities and agree Section structure, admin details.
Discussion in subgroups to provide detailed timed agendas for Tuesday and Wednesday
Tuesday 0900 - 1800
Presentations on S.Hake angler Nephrops, Baltic cod
Discussion for conclusions
Wednesday 0900 - 1800
Presentations on Kat, NS, IS and WoS cod and NS whiting.

Discussion for conclusions
Thursday
Draft text and first drafts of conclusions
Friday
Draft text and final drafts of conclusions
Friday 1500 Meeting close

4.3. Reports

The TOR requires separate reports of the meeting for each task. This report deals specifically with Baltic cod Impact Assessment. Three other reports are prepared, an overall ICES STECF report containing details of the whiting response, and separate reports one for Southern hake, angler and Nephrops, and the other for the four cod plans Kattegat, North Sea, West of Scotland and Irish Sea.

4.4. Participants

The full list of participants at EWG-11-07 is presented in section 15.

5. OVERVIEW OF BALTIC MULTI-ANNUAL PLANS

5.1. Problem statement

A multi-annual plan for the cod stocks in the Baltic Sea and the fisheries exploiting these stocks entered into force on 01 January 2009. The plan includes an obligation for the Commission to evaluate the impact of its management measures in the third year of its application, and in each subsequent year based on advice by STECF and the BS RAC. In addition, the Commission is obliged to seek scientific advice by STECF on the rate of progress towards the plan's targets every third year, and to propose modifications of the measures as it deems necessary to reach the plan's objective. In addition, the Commission shall propose new target fishing mortalities in case STECF advice indicates they are not in accordance with the plan's objective.

The STECF report of the subgroup on Management Objectives and Strategies (SGMOS 10-06), Part e Evaluation of the multi-annual plan for Baltic cod (Council Regulation (EC) No 1098/2007) reveals that there are number of design issues associated with the wording of the plan, regarding the calculation of the target F and changes to effort. The same report concluded that in comparison to the eastern Baltic stock, the western Baltic stock has not shown any significant signs of recovery. There is a need for additional protection of the Western Baltic cod stock other than obtained from the measures in the management plan. Although simulations suggest that target fishing mortality of 0.6 will be reached by 2015 provided that there is compliance with the plan, the current management target for western Baltic stock is not compatible with current estimate of Fmsy in the long term.

The report suggested for consideration a range of additional aspects in case of the major revision of the Baltic Sea cod plan. Additionally, a number of issues for consideration by STECF in the Impact Assessment exercise were identified in a workshop with stakeholders on 23 February in Brussels.

6. OBJECTIVES

The objective of the Common Fisheries Policy (CFP) is to provide for sustainable exploitation of living aquatic resources in the context of sustainable development, taking into account of the environmental, economic and social aspects in a balanced manner. This objective is more effectively achieved through a multi-annual approach to fisheries management, involving multi-annual management of stocks at or within safe biological limits. For stocks outside safe biological limits, the adoption of multi-annual recovery plans is an absolute priority. The 2002 CFP reform included for the first time the possibility to manage under EC legislation for the long-term. Many stocks were then gradually brought under long-term plans in period from 2003 onwards. Today, however, the EU has dropped this distinction between recovery and management plans and refers only to "multi-annual" or "long term" plans. Whatever the situation of the stock, the goal is ultimately to reach maximum sustainable yield by setting an appropriate exploitation rate. The conservation (i.e. measures required to maintain or restore natural habitats and the populations of species of wild fauna and flora) objectives laid down in EU environmental legislation as well as objective to achieve the stock maximum sustainable yield by 2015, as agreed by the Member States at the 2002 UN World Summit on Sustainable Development, should be followed. The initiative is complemented by fisheries actions as specified under the Baltic Sea Strategy.

Specific objectives for the Impact Assessment to look on the following scenarios:

The specific objective is to achieve Fmsy as defined by ICES by 2015

6.1. Biological objectives:

6.1.1. Single stock MSY targets

A study to evaluate target and ranges of constant F exploitation for both Baltic cod stocks, based on available assessment data (ICES 2011) is given Annex 1. Recruitment is modelled though stochastic multiple model based simulation for 1000 constructed "populations" for each stock. S-R models were fitted in a Bayesian framework, three models S-R models were applied, Hockey-stick (HS), Ricker (RK) and Beverton-Holt (BH) using a single model specific slope factor for each model type, (BH, HS and Rk). The probability of each model type is selected for the set using the statistical method proposed by Kass and Rafferty (1995) applied as described in detail for S-R functions in Simmonds et al (2011). Variability in growth maturation and selection in the fishery is obtained by drawing historically observed values at random from the assessment data. To account for differences over time up to three different groupings are selected for comparison. The range of years use to contribute to data input is given in Table 1 in Annex 1.

Based on single stock analysis there is insufficient data to detect differences in S-R resilience (slope to the origin) across stocks or between periods. Differences in carrying capacity are different across stocks and periods, particularly for Eastern Baltic cod. The full set of results is given in Annex 1. Given the uncertainty in the available data and fitted models, the best point estimates of Fmsy for single species exploitation suggest that the choice of values is not heavily dependent on growth, selection or recruitment period (assuming consistent resilience across periods and stocks).

The estimated Fmsy target values and the range over of F over which yield are maintained within 95% of yield at Fmsy (Figure 6.1). High yields (>95% of yield at Fmsy) can be obtained between F=0.2 to 0.5 and that maximum yields for a fixed F exploitation are estimated to be a little above 0.30, maybe up to 0.33, for both stocks (Eastern F averaged over ages 4-7 and Western F averaged over ages 3-6). The study suggests that robust single species target values for Western Baltic cod would lie in this range. The analysis for Eastern Baltic cod indicates that the current value of 0.3 is an appropriate option.

These studies do not include assessment or implementation error. It is expected that such errors occur in practice and that these should be considered when using these targets. This implies that if managers wish to exploit at a target value such as Fmsy there should be a 50% probability of being above or below the target, but for boundary values such as the upper and lower 95% yield values (of around 0.2 and 0.5) there should be a high probability of being inside these boundaries, thus such boundaries should not form targets but limits to be avoided.

Both these stocks have shown reduced growth at various times. For Eastern Baltic cod the current Fmsy implies an equilibrium biomass a little above the historically observed range of biomass, so the differences between observed and expected SSB are comparatively small. As the historic time series for Western Baltic cod (1970 to 2010) is for a period of higher exploitation, the Fmsy from this analysis implies a shift in exploitation giving an SSB higher than observed during this period. The causes of reduced growth are not fully understood so the appropriate action that should be taken is uncertain. This suggests that more research into multi-species interaction affecting growth would be beneficial for understanding the appropriate management response.

The study in Annex 1 also examined the utility of using a simple fixed Hockey stick model for MSE evaluations. In order to test for the possibility of simplifying the modelling, for use in evaluations, the estimates of Fmsy and >95% interval were repeated using fixed or variable coefficient HS models only. Ignoring the uncertainty in S-R modeling gave slightly different target values for both stocks and for Eastern cod indicated greater stability in catch over F than is suggested if modeling uncertainty is included. The study also concluded that if the primary objective is to understand variability, and not to select target values it is probably acceptable to evaluate these stocks with simulations based on fixed parameter HS S-R model. This simplification is conditional on the assumption that F for Eastern cod remains within 0.2 to 0.45 which should be acceptable given the current F.

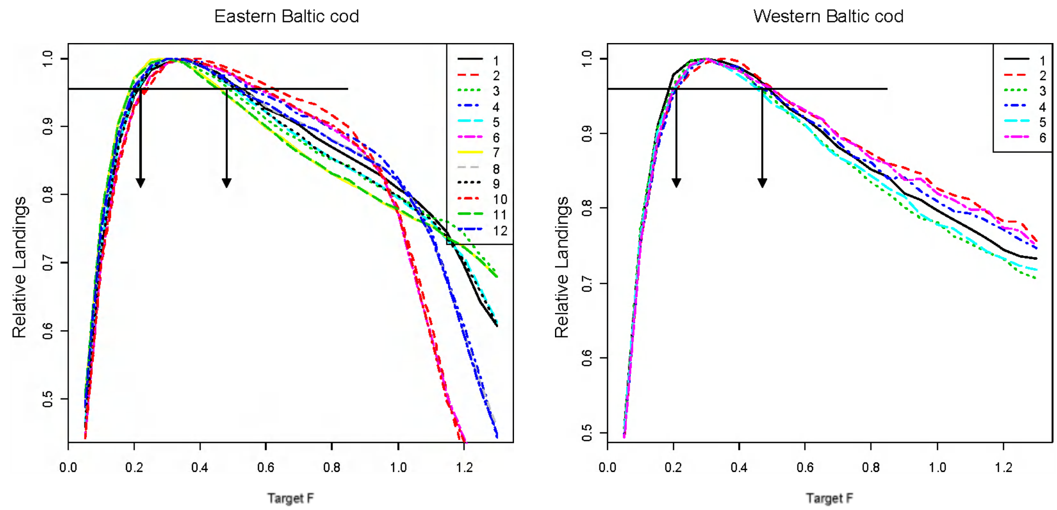


Figure 6.1 Relative mean landings under constant F exploitation for a range of S-R, growth, maturation and selection options tested for Eastern and Western Baltic cod. Mean F is over ages 3-6 Western and ages 4-7 Eastern stock. The mean catch illustrates the showing the relatively stable relative maximum yield for different stock conditions between 0.3 and 0.33 for both stocks, and the range of F (~0.2 to 0.5) over which >95% of average yield at Fmsy is expected.

6.2. Economic and Social objectives

There are no economic objectives beyond general CFP aims which could be articulated specifically for the Baltic. The Baltic is characterized by a larger number of small scale fisheries which can be of higher importance for coastal communities with respect to employment and tourism. However, these fisheries are usually excluded from effort regimes, and therefore they are affected to a lesser extent specifically through LTMP measures.

In general, the LTMP should provide stability by curbing the range of inter-annual TAC variations. Maximum economic yield (MEY) is to be regarded as an economic objective of the LTMP. However, this could only be addressed if there were clear specifications on the fleet segments under consideration. In focusing on the fleet segments mostly dependent on Baltic cod and mostly contributing to the total cod landings the impact assessment has already defined a certain focus on fleet segments.

6.3. Comparison and Conclusion to objectives

The basis for the discussions of objectives for management of the Baltic cod stocks were the overall objectives of the CFP and the objective on the current multiannual management plan.

The objectives of the CFP are among others to ensure exploitation of living aquatic resources that provides sustainable economic, environmental and social conditions. The aim is to restore and maintain populations above levels which can produce maximum sustainable yields not later than 2015.

The objective of the current plan (regulation 1098/2007) is to ensure the sustainable exploitation of the cod stocks by gradually reducing and maintaining the fishing mortality rates at levels no lower than:

(a) 0.6 on ages 3 to 6 years for the cod stock in subdivisions 22 to 24; and

(b) 0.3 on ages 4 to 7 years for the cod stock in subdivisions 25 to 32.

Based on the analyses described above the Workshop notes that:

- Based on single species considerations that high yields and low risk to the stock size can be obtained with fishing mortalities between 0.2 and 0.5 and that maximum yields are achieved at F= 0.33 (FMSY) for both stocks (ages 4-7 for eastern area and ages 3-6 western area).

- For the eastern area this figure is at the same level as the current target F and applying it as target F will have very limited consequences in terms of yield and stock development compared to the present target.
- For the western stock it represents a large reduction in the target F and simulations indicate that exploiting the western stock at F=0.33 may result in a substantial increase in stock size to levels above historical values. It is not possible to assess the impact such high stock sizes may have on the ecosystem and the stock dynamics.
- Available multispecies analyses for the eastern cod stock indicate that FMSY may depend on the stock size with MSY been obtained at different F levels when the stock size is high.

In conclusion the Workshop considers that within the historical stock sizes exploitation of the two cod stocks at target fishing mortality levels of 0.33 is consistent with the objective of MSY. If the stock sizes increase to a state where it influences the population parameters it may be necessary adapt target fishing mortality to obtain MSY.

7. IDENTIFYING TACTICAL METHODS

Introduction

At the joint ICES-STECF meeting of 28 Feb to 4 March 2011 (STECF 2011) the group was requested by the EU Commission and Member States to evaluate the effectiveness of a number of control measures in the Baltic cod long term (multi-annual) management plan (LTMP). In particular, STECF was requested to consider requirements for fishing effort limitations and TAC limitations for Eastern and Western Baltic cod management, to consider if the effort regime does or does not make a positive or negative impact on management, to consider to the extent to which the effort restrictions will help in achieving targets of the LTMP, and to consider if the management can be made simpler. To do this among other the following tasks were identified:

- Document effort and capacity ceilings by country
- Document to the extent to which effort quotas and TACs (in the management plan and previously) have been restrictive, by fishery/métier/fleet and country, through information from national administrations. Document actual quotas and quota uptake both for effort and TAC. List effort restrictions in relation to utilized capacity by country and fishery.
- Describe recent developments in compliance in relation to TAC and effort restrictions in the E. Baltic Sea and the W. Baltic Sea compared to historical information on this.
- In relation to values of baseline effort and utilized effort, evaluate the relationship between F and overall effort by management area and cod stock – and possibly by segment in relation to potential fishing power differences

In order to accomplish this, the EU Commission has sent a data request to the relevant national administrations of the member countries by 19th April 2011 to deliver the requested data by May 18th 2011.

Preliminary analyses on the data delivered by the National Administrations according to the data request and the above listed tasks is presented in table and graphical form in the present working document to EU STECF EWG 11-07.

The results on preliminary analyses of effort and TAC restrictions as well as capacity utilization by country are presented in the working document "Evaluation of Effort and TAC Quota Uptake and Capacity Use" (Annex 2). Also, results and conclusions on preliminary analysis of correlations between effort and fishing mortality as well as preliminary analyses of fishing power differences between fleet segments and fisheries are given in this working document.

The listed tasks have been addressed in preliminary analyses preparing summary tables and figures of effort and TAC and quota uptake as well as capacity ceilings and capacity utilization for each country according to various fisheries/fleets/metiers to show to which extent the quotas have been restrictive or not during the period 2005 to 2010 in the international Baltic cod fisheries and whether changes could be observed in quota up-take and capacity utilization in relation to introduction of the Baltic cod LTMP. The results and conclusions are partly shown separately by country as well as summarized in the working document.

In general, there are (small) differences between countries in the methods used to estimate the effort and TAC quotas and quota up-take as well as in the estimation methods of capacity ceilings and capacity utilization (i.e. methods of categorizing, defining and estimating this) by the respective national administrations. However, it should be noted that in relation to introduction of the cod management plan during the period 2007-2008 and evaluation of potential changes in utilization there is comparability within country in the period 2005-2010, and comparison of major differences between countries are valid.

7.1. Capacity changes

The capacity utilization by country and fleet/metier is illustrated in Figure 7.1.1 and further discussed in Annex 2. In relation to the information obtained from the national administrations on capacity under the above mentioned data call it should be noticed that data provided on capacity ceilings varied from country to country. The capacity ceiling, measured in kW, should be established in accordance with article 10(2) of Council Regulation 1098/2007, for vessels holding special cod fishing permits in 2005. For capacity calculations the capacity ceilings are set at a certain level for each country, taking 2005 as reference year. Furthermore it has to be noted that data on the number of cod permits granted can differ as these sometimes include inactive vessels as well as the year's active vessels holding a special permit for fishing cod. The number of fishing permit users supplied by MS can include inactive vessels, which may make the results of calculations hard to interpret.

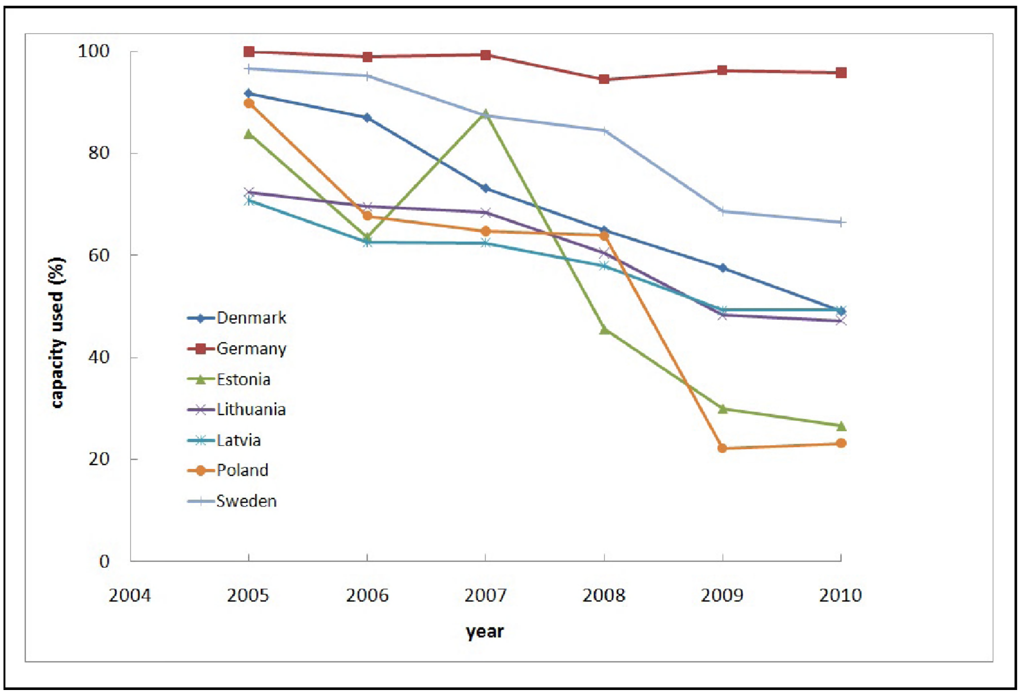


Figure 7.1.1 Capacity utilization for the Baltic Sea in international comparison for the period 2005-2010

Poland indicates the greatest loss of capacity used in the Baltic Sea fisheries, closely followed by Estonia. Denmark also indicates a significant decline of capacity used, followed by Sweden, Latvia and Lithuania. The only member state which capacity is almost fully constant and utilized in the period 2005-2010 is Germany. Even though the data may not be fully comparable between countries because there are differences in the methods used to define how capacity and capacity utilization has been estimated, there seems to be a tendency for Estonia and Poland of a significant decrease in capacity utilization from 2007/2008 to 2009 (when the management plan was introduced and enforced) to a lower level approximately maintained in 2009-2010.

7.2. Effectiveness of TACs to control catch

Results and conclusions on preliminary analysis of TAC utilization and quota uptake in relation to the cod LTMP for the countries participating in the Western and Eastern Baltic cod fisheries are given in Annex 2.

According to the data delivered by the national administrations as provided under the data call associated to EU STECF EWG-11-07 Baltic cod management plan evaluations (section 7.0) there can be observed some general trends. However, the background for the degree of TAC utilization can be very diverse according to year and country, and lack of full utilization does not necessarily mean that TACs have not been restrictive, which is important to note. Consequently, the data should be used with caution.

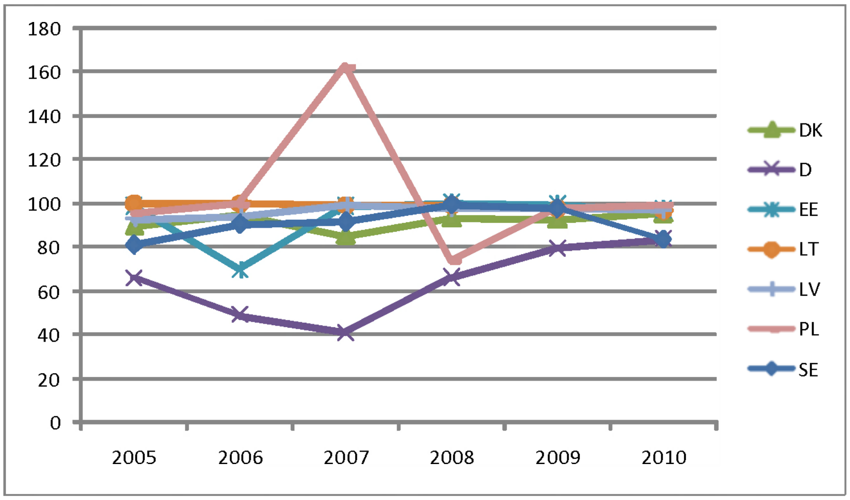


Figure 7.2.1 Eastern Baltic Sea TAC Utilization by country during the period 2005-2010 according to the data call made in relation to among other the EU STECF EWG-11-07.

For the Eastern Baltic Sea the national cod TACs are in general fully utilized for most countries during the period 2005-2010, and in one case overshot. Only Germany seems not to have fully used its cod quota in the Eastern Baltic Sea especially in the early years of the period, but there is an increasing German utilization being more than 80% in 2010. No trends in TAC utilization according to implementation of the Baltic cod management plan (introduced from 2007-2008 onwards) can be observed for any countries.

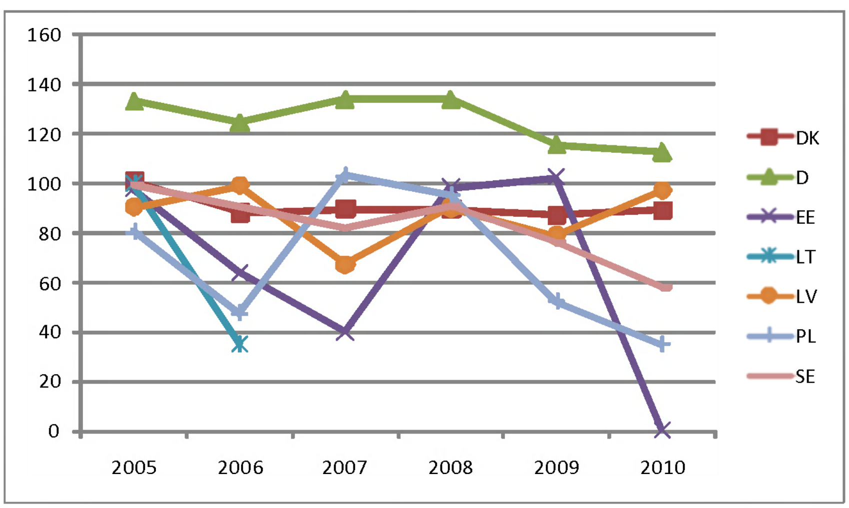


Figure 7.2.2 Western Baltic Sea TAC Utilization by country during the period 2005-2010 according to the data call made in relation to among other the EU STECF EWG-11-07.

For the Western Baltic stock the TAC utilization is more variable among countries and years during the period 2005-2010. The TAC uptake is for certain countries consistently around 100% or even above 100% during the whole period, e.g. DK, D, and LV, while for S there has in the latest year (2010) been a significant decrease from a previous similar level. The quota uptake by PL varies over the years, and there is observed low levels in most recent years. It is not possible to detect any clear trends or changes in quota uptake according to introduction of the LTMP.

There can be several reasons for either not using fully or overshooting the TAC for a given year by a country. Some of the reasons can be transfer of TAC between years for at given country, exchange of TAC between countries, individual transferable quota system where certain vessels do not fully use their individual quota share, internal national TAC distribution schemes over the year preventing use of the last part of the TAC in the last part of the year e.g. because of unfortunate weather conditions for fishery here, local variability in the resource availability in relation to fishing localities used by the fishermen for a certain country, etc. In general, the TAC constraints (as landings controls) under the LTMP are evaluated to have been restrictive, efficient and complied with both for the Eastern and Western Baltic cod fishery.

7.3. Evaluation of Effort restrictions in relation in relation to objectives:

7.3.1. Effort quota utilization in the International Baltic cod fisheries

The results on preliminary analyses of effort quota uptake by country are presented in the working document (Annex 2). These results and conclusions are presented by country as well as summarized internationally in the working document.

Below is given summary figures of effort quota uptake by year and country according to various fisheries/fleets/metiers to show to which extent the quotas have been restrictive or not during the period 2005 to 2010 in the international Baltic cod fisheries and whether changes could be observed in quota up-take in relation to introduction of the Baltic cod LTMP.

The results and conclusions obtained from the analyses made in the working document can be summarized into the following considerations:

1) The current effort ceilings have been restrictive for only a smaller proportion of vessels (less than 10%, and in given case mainly for gillnetters)

2) Up to now effort control has probably not provided significant restraint in the fishery

3) The current effort restrictions are unlikely to prove a significant restraint in the next 1-2 years unless made more restrictive. However, it needs in this context to be noted that present fishing mortality for both the Eastern and Western Baltic cod stocks in 2011 is forecasted to be below FTARGET resulting in either constant or increase in the effort ceilings (under the current targets) for 2012 for both fisheries as well as for the Eastern Baltic cod for 2011.

4) As there is a considerable level of surplus unutilized effort and capacity available, introduction of effort trade under the present regime with or without fleet based exchange rates also taking into account differences in fishing power would prolong the period over which effort restraint is largely ineffective (acknowledging that trade in effort would have a cost so would be intrinsically a restraint)

5) If effort constraint for the fishery was considered to be important as a control measure a number of changes would need to be considered, among other:
   a. Effort allocations per vessel based on track record (similar to TAC allocations)
   b. Utilization trade in effort requiring fleet based exchange rates.

6) Transfer of effort between segments, as well as use of effort management to reduce F by enforcing reduction in E, need to take into account and compensate for variability between métiers in the correlation between effort and fishing mortality (see also section 7.4.2 below)
   a. Conversion factors between different métiers depend on the effort measures used
   b. Fishing power for cod differs between different métiers
   c. Likely temporal trends (technological creep) in the relationship between effort and fishing mortality in general

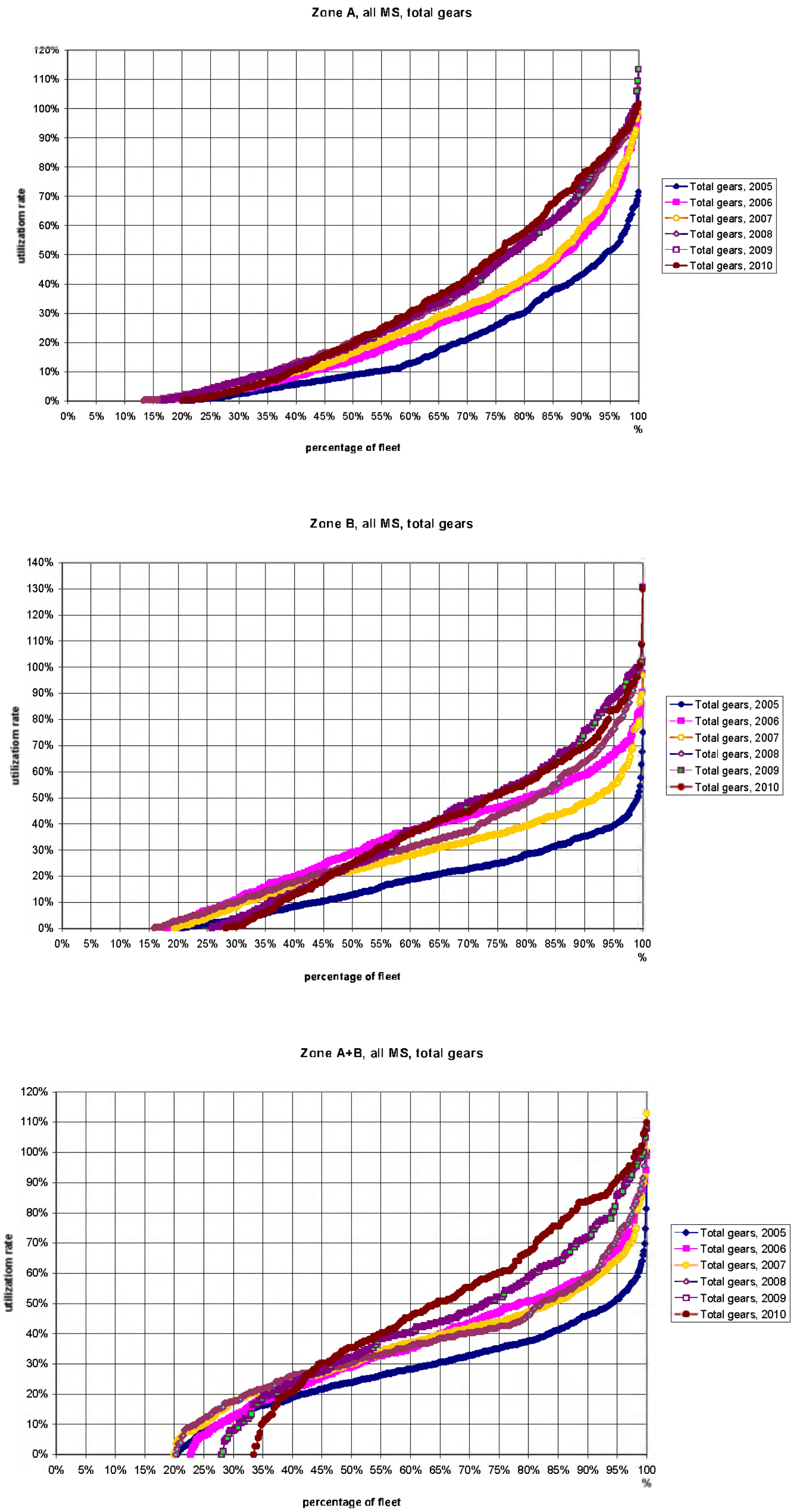
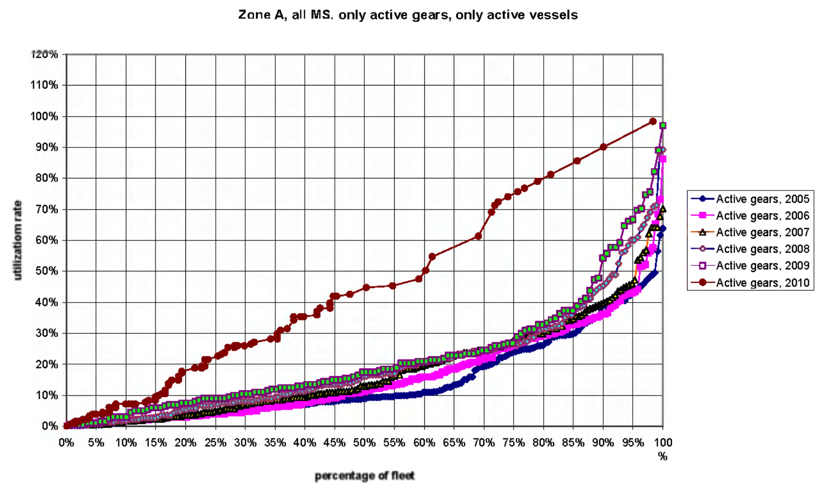
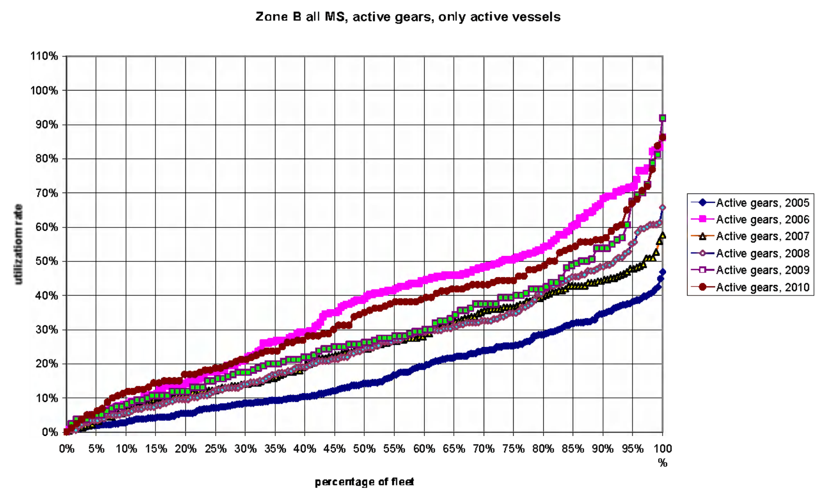


Figure 7.3.1 Summary of fishing effort utilization rate at individual boat level in percentage by main gear and management area in the international Baltic cod fishery during the period 2005-2010 (all member states).





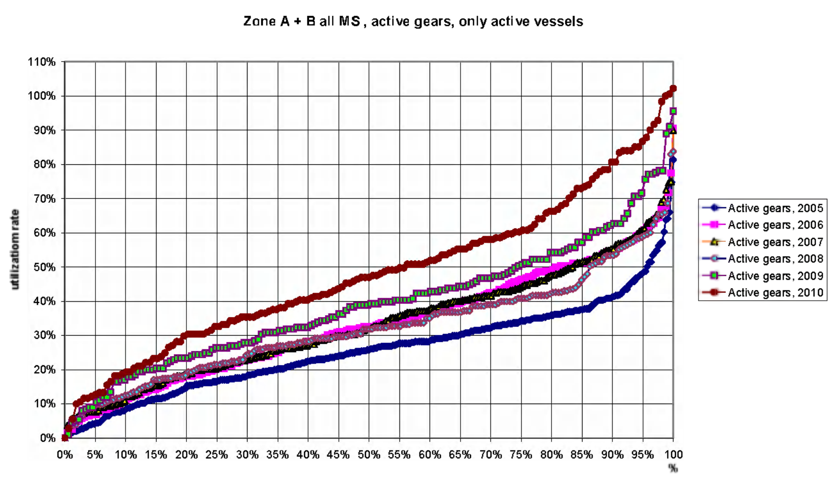
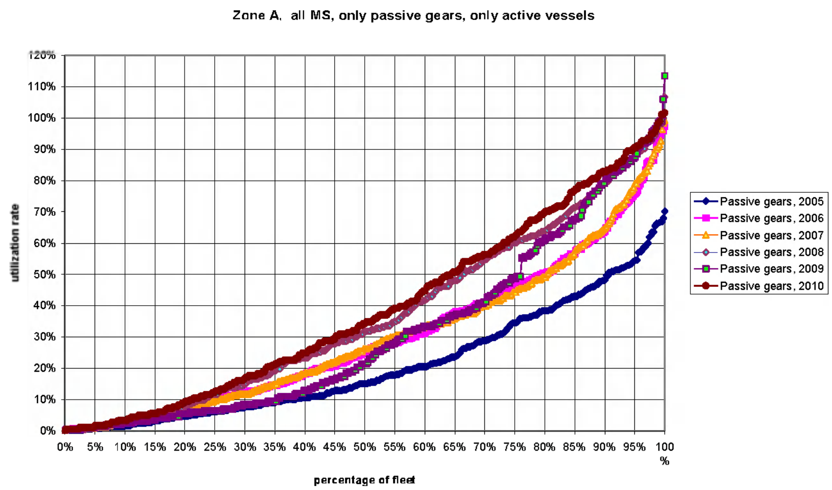
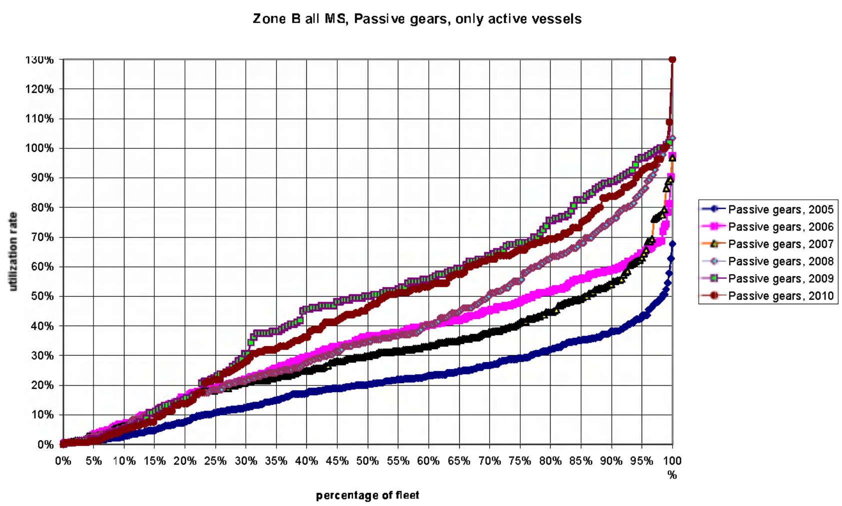


Figure 7.3.2 Summary of fishing effort utilization rate at individual boat level in percentage for active gears (and active vessels) by management area in the international Baltic cod fishery during the period 2005-2010 (all member states).





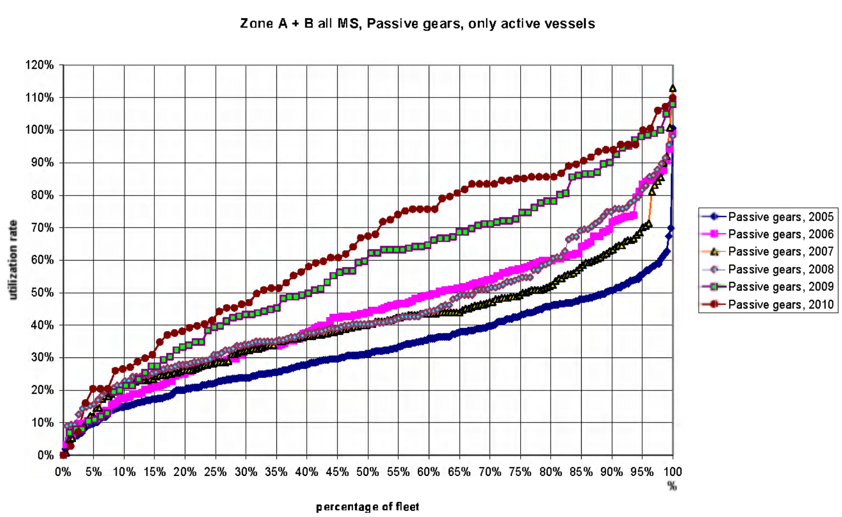


Figure 7.3.3 Summary of fishing effort utilization rate at individual boat level in percentage for passive gears (active vessels) by management area in the international Baltic cod fishery during the period 2005-2010 (all member states).

7.3.2. Correlation analysis between different Effort Measures in the Baltic cod fishery

Results and conclusions on preliminary analysis of correlations between different effort measures are given in the working document in Annex 2.

The aim has been to evaluate the consistency among different effort measures as well as to compare efficiency of different effort measures in relation to the LTMP (e.g. kWdays, days absent from harbour, and other fishing activity measures). This includes investigation of variability between segments and over time with respect to potential differences in fishing power.

Annex 2 presents results from investigations on effort measures using data at different aggregation levels. For Danish vessels investigations of consistency between different effort measures (days-at-sea, calendar-days and kWdays) using disaggregated data on trip level by fishery (métier) for both the Western and Eastern Baltic Sea fisheries are carried out. Aggregated national fishery data on days at sea and kWdays (STECF 2011a) by year and fleet/fishery for the period 2005-2010 have been have been investigated for the Danish, German and Swedish fisheries in the Western Baltic Sea.

The disaggregated Danish data investigates two metrics:

- Calendar days = no of calendar days at sea (for each date registered in the full trip length)
- Days at sea = (arrival time – departure time) / 24

The first measure is used on EU level to initially allocate number of fishing days to the vessels according to the EU effort quotas, while the latter method typically is used by the national Fisheries Directorates to account used effort in fishing days according to the quota, i.e. according to enforcement of restrictions according to the management plan. Such a switch can introduce an increased in available effort.

The results of the analyses on trip basis for important métiers in the Baltic Sea by area in 2010 indicate that there is a relatively good correlation, but not full consistency, between the days-at-sea and calendar-days effort measures for all important Danish métiers in the two areas.

The extent of correlation between days-at-sea and kWdays is more variable between métiers with a wider spread in kW within métiers for 2010. The spread in the kWdays effort measure is greater than for days-at-sea and the calendar-day effort measures because it includes a spread in kW by vessel for each métiers. There also seems to be difference in the correlation between effort measures among métiers using active gears compared to those using passive gears.

The evaluation of consistency between days-at-sea and kWdays effort measures when using aggregated data from the SGMOS-11-06 by year and fleet/fishery for the period 2005-2010 for the Danish, German and Swedish fisheries in the Western Baltic Sea also indicate good correlation, but not complete consistency.

Overall, these analyses indicate that there in general is a relatively good correlation, but not complete consistency, between the different effort measures. Both the disaggregated and aggregated data analyses show that there is variability among métiers. Accordingly, the efficacy of common effort measures can be questioned, suggesting different reductions in E between métiers dependent on which effort measure there is used. The reduction in F according to reduction in E will be dependent on the number of factors differing among segments, see Section 7.3.4. below.

The Workshop draws the following conclusions for defining effort measures.

The kWdays measure depends considerably on the vessel engine capacity which is thought to be important for fisheries using active gears (e.g. trawl, seines), and is preferred over days at sea for these fisheries.

For fisheries using passive gears (e.g. gillnet, longlines) the STECF recommended measures of number of hooks or length of net combined with soak time for passive gears are more appropriate than the current days at sea measure.

It is recommended that for all effort measures the method used to calculate effort used should be the same as the method used to allocate and monitor effort (Annex 2).

7.3.3. Correlation between Fishing Effort and Fishing Mortality

Background and analyses performed

Results and conclusions on preliminary analysis of correlation between different effort measures and fishing mortality for the international Western and Eastern Baltic cod fisheries are given in the working document in Annex 2.

In relation to values of baseline effort and utilized effort, the purpose of the present investigation is to evaluate the relationship between fishing mortality, F, and overall effort, E, by management area and cod stock – and possibly by segment in relation to potential fishing power differences. Concerning the used effort measures and baseline effort settings the aim is to evaluate the relationship between F and E and possible temporal development herein in order to evaluate fishing power differences over time and/or between fleet segments. The results of the analyses indicate whether it is possible to re-distribute effort within and between segments without increasing total effort (E) and fishing mortality (F) and still reach the management targets. As such it considers the flexibility with uni-directional or bi-directional effort transfer among segments and within segments.

The EU STECF SGMOS 11-06 has produced correlation plots of fishing mortality F versus fishing effort E for all international Baltic cod fisheries combined by main gear (active and passive gears) and main area (Eastern Baltic Sea) for the most recent 5-year period.

Furthermore, developments over time within and differences between Danish Baltic cod fishing fleets have previously been analysed in Nielsen (2000) and Marchal et al. (2001).

In relation to the FLR management plan evaluations and simulations produced to EU STECF EWG-11-07 there has been performed multivariate GLM statistical analysis of fishing power differences between different international Baltic cod fisheries and métiers covering the period 2005-2009. This analysis has resulted in estimated average catchabilities by métier for this period as presented in the working document.

Finally, there has in present context been made correlation plots of F vs E on a more disaggregated basis for individual international fisheries and métiers for the period 2005-2009 where both effort and landing data have been available on métier and area disaggregated basis to perform such analyses. The results of this preliminary analysis are also presented in the working document.

7.3.4. Results and conclusions

Nielsen (2000) and Marchal et al. (2001) found fishing power differences between different fleet segments and vessel size classes in the Danish Baltic cod fisheries as well as an increase in fishing power over time within the fleets and fisheries among other according to vessel size. Both analyses using two different methods to estimate fishing power by segment found a continuous small, but significant increase for nearly all segments over time during the investigated 10 year period in the 1990'ies.

On basis of the more aggregated plots of F versus E in the recent international Western and Eastern Baltic cod fishery in the period 2005-2010 then it is in STECF SGMOS-11-06 report concluded that the relationships between fishing mortality and effort deployed (for all regulated gears combined) are on such an aggregated basis relatively strong for Western and Eastern Baltic cod fisheries. According to STECF SGMOS-10-05, the results change to some extent depending on whether the analysis is based on F from ICES assessments or an STECF estimated partial F assuming that effort data show the same bias as STECF catch estimates (i.e. without unallocated removals) compared to ICES catch estimates (i.e. with unallocated removals). The general conclusions, however, hold true for both types of analyses. It is furthermore in SGMOS-10-05 concluded that the relationship is to some extent spurious and other factors besides effort reductions are responsible for the drop in F during the last years. For example, improved productivity of the stock and the TAC constraint of +/-15% in the cod management plan contributed to this. Therefore interpretation of these results should be treated with caution.

In relation to the FLR simulations performed for EU STECF EWG-11-07 there has been performed a statistical multivariate GLM analysis of fishing power by segment (métier) for the Western Baltic cod fishery during the period 2005-2009 in order to scale the fishing power between segments. This was performed as an GLM analysis of CPUE by fishery (segment) where the spatial (geographical) and periodical effects were taken into account in order to calculate an average fishing power (catchability, fishing efficiency) difference between segments as averages for the period 2005-2009 in the Western Baltic Sea. The results from this preliminary analysis are consistent with similar results of analyzing fishing power in Danish Baltic cod fisheries presented in Nielsen (1999) and in Marchal et al. (2001) where there are documented significant differences in catchability and fishing power between different segments according to fishery (gear type, vessel size, etc).

The results of the preliminary analysis of correlation between F and E on a more disaggregated basis for individual international Baltic cod fisheries and métiers by area for the period 2004-2009 where both effort and landing data are available on métier and area disaggregated basis to perform such analyses are based on use of effort in fishing days and in kWdays, respectively. The results indicate that the correlation between effort and fishing mortality on a more disaggregated level on international métier and area basis varies considerably between different fisheries and metiers by area in the international Baltic cod fisheries. For some métiers there is a high correlation while the dependency is indicated to be low for other fisheries in both areas, and the slopes of the correlations also varies considerably indicating fishing power differences.

In conclusion, possible transfer of effort between segments and countries should take differences in fishing power into account in order not to increase of F by transfer of effort between segments. Even though EU STECF SGMOS-10-05 and EU STECF SGMOS-11-06 results indicate a good overall correlation between E and F for Eastern and Western Baltic cod fisheries on an aggregated basis by main gear, the correlation on a more disaggregated level by international métier and area indicates that the correlation varies considerably between different fisheries and metiers by area in the international Baltic cod fisheries. Overall, the results of the analyses indicate that re-distribution of effort within and between segments will potentially increase total effort (E) and fishing mortality (F), unless the fishing power differences are taken into account a when transferring effort. Estimates of the relative fishing power segment can be made available.

7.4. Spatial and temporal restrictions

In the present Baltic cod management plan, there are two different closed periods aiming at protecting aggregations of spawners – in April for the Western Baltic (22-24), in July and August for the Eastern Baltic (25-28). In addition, three areas known as important spawning areas in Bornholm Sea (SD 25) are closed for most of the year (May-October).

The present plan does not clearly indicate which fraction of the spawners should be protected. Any protection of spawners can in theory have benefits for recruitment success, either directly by allowing fish to spawn before they are caught or indirectly by reducing the disturbance during the spawning process. Also, cod usually aggregates during spawning and can thus be easier targeted by the fishery – a closure would therefore change the exploitation pattern. However, it is very difficult to prove these theoretical benefits in practise (i.e. in terms of improved recruitment), mainly because environmental factors play a bigger role in determining the strength of a year class and thus mask potential effects of spawning closures. In addition, the closure of areas or certain periods will likely lead to a displacement of effort and therefore might balance some of the benefits of reduced fishing pressure on the spawning grounds, and could even lead to a higher pressure on juveniles.

No formal temporal or spatial restrictions with the aim to protect spawners apply to recreational fisheries in the Baltic. However there are voluntary measures in place for some areas to discourage the targeting of spawners by recreational fisheries.

An analysis of the timing of spawning using data from 1999-2010 and differentiating between first time- and multiple spawners, males and females and the different areas of the Baltic (STECF 2010), suggest that in the Eastern Baltic the present closures are at the appropriate time to protect spawning aggregations. There is an ongoing scientific debate whether the present permanently closed areas in the Bornholm Sea are sufficiently large enough to contribute effectively. In the Western Baltic, the present closed period seems to reasonably protect first time spawners in the Belt Sea (SD 22). However, for a protection of older females (multiple spawners) which are suggested to contribute more valuably to overall recruitment, the optimal effect of a temporal spawning closure would be achieved if a 6-wk period would be closed between beginning of March and mid of April in SD 22, and beginning of June and Mid of August in SD 24. The analysis also suggests that spawner aggregations are only found in the Western Baltic in water depths below 20 m.

Conclusion: If temporal spawning closures are maintained, they should be kept at the present time in the Eastern Baltic, but split into two separate periods (March to mid April in SD 22, and June to mid August in SD 24) for the Western Baltic if the effect of this measure should be maximised.

Summary of options for the future

a. status quo – leave unchanged

   no administrative change needed, protection of the most valuable spawners in WB not optimal (considering this measure only), no flexibility for small coastal vessels

b. abandon closures completely

   no control and enforcement problems, maximum opportunities for the fishery, loss of potential protection of spawners, problems in communication as it abandons a well-introduced concept, likely that some fisheries (specifically recreational fisheries) start to target spawning aggregations and therefore increase partial F

c. split and move closures for WB cod

   more effort for control, makes measure more effective, gives larger vessels sufficient flexibility

d. split, move and extend closures for WB cod

   maximum effect of this measure, detrimental for small coastal fishery which has no alternative fishing opportunity during a longer period

e. additional measures/ideas to mitigate effects for the fishery

   allow for fishing shallower than 20 m in WB as the resource to be protected occurs below 20 m, high administrative burden, needs reversal of burden of proof (fishers to demonstrate that they are not entering areas deeper than 20 m), but gives small coastal fisheries maximum flexibility – combines benefits of options b and d

7.5. Enforcement and control

7.5.1. Overview of enforcement options

Using effort regulation as the only management measures needs detailed information and documentation of fishing activities, for instance using VMS data and electronic logbooks (both currently only required for vessels above 15 meters). The main advantage of effort regulation compared to TAC regulation is that it is relatively easier to control and enforce compared to a system based on TACs. On the negative side are the challenges in setting the correct level of effort for different fleets and gear types, if these are to be in correspondence with the biological advices. Furthermore, the incentives to invest in improved efficiency of the fishing vessels are increased, thus requiring strict capacity management and/or yearly reductions in the allowed number of days at sea. Under the current TAC regulation, the technical improvements are already calculated be 5% per year (Marchal *et al* 2007). Finally, if reallocation of effort is allowed, it is also necessary to define reallocation keys between the different fleet and gear types, given that there is not necessarily a 1:1 relationship in the resulting catches (see above). As an isolated effort system increase incentives to invest it increases the risk of non-compliance as situations of economic losses become more likely (high investments compare to stable fishing opportunities).

TAC regulation is used as the main management instrument in primary part of EU fisheries today. The TAC system needs effective control activities for the catches/landings. The advantage of such a regulation is that, when applied to catch not just landings, it is clearly linked with the biological assessed stock developments. Within a TAC system, it is easy to implement a tradability system. When individual fishermen receive parts of the quota, the system can be very effective in terms of reaching the right level of fleet capacity compared to fishing opportunities. If fishermen are able to trade fishing rights the quotas will be fished out with the least cost in an optimal situation. If reallocation is not allowed an effort regulation may be necessary as supplement for capacity management. The disadvantage of the TAC system is that in many cases unwanted bycatch of a target species (undersized individuals) or the bycatch of a species in a fishery targeting a different stock are not currently accounted against the quota. This could easily lead to overfishing. As a TAC is today basically landings and catches can be substantially different from landings. Unreported and unwanted catches increase fishing mortality if the TAC is not properly enforced. However, new technological developments can help to reduce this.

In a combined effort and quota system, the advantage could be that these two instruments are fit very well together. The TAC management secures correspondence between catches and the biological recommendation, while the effort management makes control and enforcement easier. The main problem is the need to set the effort level for different fleets so it corresponds with the TAC level. If this is not the case, one of the measures will be binding before the other one, thus leading to underutilisation of either the TAC or the effort. This seems especially problematic in small scale fisheries and can lead to significant economic inefficiencies. In the Baltic cod fishery several Danish and German small scale fishermen using gill nets seem to be affected, although, effort data shows that for most of the fleet segments effort is not fully utilized (See above and Annex 2). Furthermore, it will have negative economic effects if a reallocation system is for instance implemented for the TAC but not for effort. However, having a reallocation system for both will give more administrative work for the fishermen in order to balance available quota with available effort thus weakening the economic performance as it could be very expensive for fishermen to obtain additional quotas or effort.

7.5.2. Current information on control and enforcement

The summary information on enforcement and control is based on data on national control action programmes provided by countries following the WKROUNDMP/EWG 11-01 data request for the Baltic Sea (Ref. Ares (2011)439284 – 19/04/2011). Information received was summarized in the current report as one table, corresponding to the information delivered, including all additional information attached by countries (Table 7.1).

According to the status of data submission (23th of June 2011), the requested information was obtained from Denmark, Estonia, Lithuania, Latvia and Poland (see Table 7.1 below). It seems that there have been differences in interpretation or at least presentation of the data requested in the tables by the Member States. Therefore it might be unreasonable to compare the data across countries. Thus, within country analysis across years was carried out. Additionally, national control programmes can not be analyzed in relation to TAC and effort restrictions in the Eastern and the Western Baltic since the data request to Member States did not specify the geographical resolution of the data to be delivered.

DENMARK. The number of inspections at sea has decreased since 2008, below the level of 2007 (before the implementation of Multi-Annual Plan). During the whole period reported, the number of inspection vessels remained unchanged (two vessels). The number of violations at sea was the highest in 2009, while in the rest of the years it was low (Table 7.1).

ESTONIA. No cod-directed control activity for 2007-2010 has been reported in Estonian waters. This results from no cod fishery in that country's waters. Estonian inspections of cod fishery in other EU waters began in 2009 with one controlling vessel, not revealing any violations.

LITHUANIA. The information on number of inspections per day at sea provided by Lithuania shows the number of violations was increasing until 2009 and next year declined sharply.

LATVIA. The number of Latvia's inspections per day at sea showed a decreasing trend with the exception in 2009. At the same time the number of controlling vessels decreased from three to zero (in 2009-2010). However, even with no control vessel in action, Latvia still reported a few violations.

POLAND. In autumn 2007, a new government was elected in Poland. Within a month, the new government announced it would accept closures of eastern cod fishery by EC and after negotiation with the Commission developed a payback scheme to compensate for Polish cod quota overshoot in 2007. Following this agreement the government strengthened fisheries inspection services and developed fleet restructuring plan accepted by European Commission. These measures as well as others applied by Baltic States as the result of Copenhagen Declaration reduced the illegal overfishing from the Eastern cod stock to less than 10% (most recent estimate by the ICES WGBFAS is less than 6%) (EU STECF SGMOS-10-06b).Similarly to Latvia, the level of Polish sea inspections has declined in 2007-2010, excluding 2009. The number of control vessels was the highest among reporting countries. Violations declined until 2009 and in 2010 increased to the level observed in 2007.

The analysis of national control action programmes did not show any clear trends in the level of at-sea inspections during the years of Baltic Cod Multi-Annual Plan (CMP) realization. The same refers to the number of violations discovered. In case of Denmark and Lithuania relatively high increase in number of inspections in 2008 (the first year of CMP implementation) as compared to 2007 was observed. The extensive vessel scrapping programmes carried out during CMP in Estonia, Lithuania, Latvia and Poland could have effected and masked trends (if any) of the control activities in these particular MS. Although the data on number of sea inspections and number of violations reported by countries did not indicate any trends it should be remembered that the data on controls of landings in harbours have not been included.

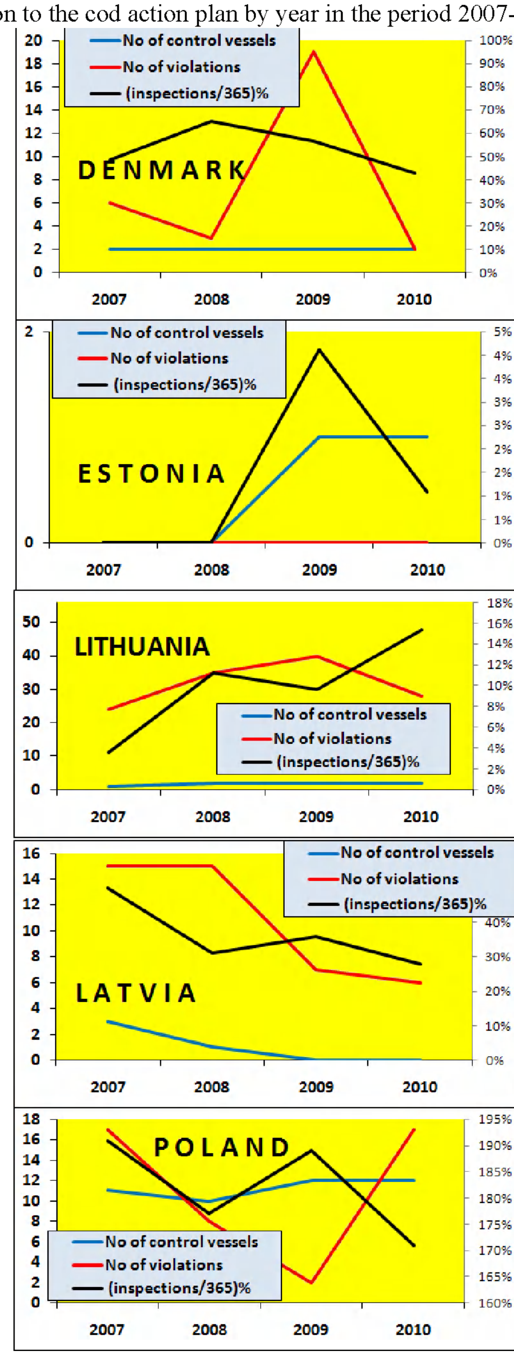
Some additional information indicating potential positive effect of more strict enforcement of fishing control can be retrieved from the Baltic Fisheries Assessment Working Group (WGBFAS) reports. In the years preceding the implementation of the CMP, the problem of under-reporting of the Eastern Baltic cod landings was clearly indicated in many of the WGBFAS reports. Information on the estimated level of unreported landings was obtained from representatives of each of the countries contributing data to the WGBFAS. EU fishery inspection evaluation report of catch registration in the Baltic Sea MS for 2005–2007 indicated that under-reporting was applicable for all Baltic countries.

Table 7.1 National contents of national control action programmes (Annex II): Level of inspection by year in total and in relation to cod fishery. Number of violations in relation to the cod action plan by year in the period 2007-2010

Country	Number of inspections	Number of control vessels in action	Number of violations
GERMANY			
2007	information not received		
2008			
2009			
2010			
Country: **DENMARK**	Number of inspections per day at sea (inspections/365)	Number of control vessels in action	Number of violations (at sea/in port)
2007	177/365	2	6/55
2008	238/365	2	3/49
2009	207/365	2	19/31
2010	156/365	2	2/32
Country: **ESTONIA**	Number of inspections per day at sea[1]	Number of control vessels in action[2]	Number of violations[3]
2007	0 / 0	0	0
2008	0 / 0	0	0
2009	0 / 15	1	0
2010	0 / 4	1	0

[1]- represents number of inspections to monitor cod fishery in Estonian waters/ in other EU waters
[2] - represents number of FPV-s to monitor cod fishery
[3] - represents number of violations in Estonian waters related to cod fishery.

Country: **FINLAND**	Number of inspections per day at sea	Number of control vessels in action	Number of violations
2007	information not received		
2008			
2009			
2010			
LITHUANIA			
2007	13	1	24
2008	41	2	35
2009	35	2	40
2010	56	2	28
LATVIA			
2007	0.50	3	15
2008	0.31	1	15
2009	0.36	0	7
2010	0.28	0	6
POLAND			
2007	1.91	11	17
2008	1.77	10	8
2009	1.89	12	2
2010	1.71	12	17
SWEDEN			
2007	information not received		
2008			
2009			
2010			



7.6. Effectiveness of additional technical measures, and possibilities to improve the acceptance of the measures in the fishery

Baltic cod fisheries are regulated by a large number of different and detailed technical measures. The most important and wide-ranging rules are a minimum landing size (currently at 38 cm) and a description of gears approved for targeting cod. These rules have changed frequently in the past (See SGMOS 2010-6b for a comprehensive list), the most recent change to the gear description was an increase of codend mesh opening from 110 mm to 120 mm in the Bacoma escape window and the entire T90 codend in the beginning of 2010. An evaluation of the effect of this change in mesh opening raises concerns about the effectiveness of such measures, and indicates that major future improvements in overall selectivity cannot be expected with the present micromanagement approach (SGMOS 2010-6b). In addition, the frequently changing rules are costly for fishers and control authorities and leave a feeling of overregulation and unwillingness to comply in the fishery. Finally, the present regulation discourage creative developments towards the improvement of overall selectivity, which could also be achieved by changes in gear setup not presently regulated (in front of the codend) or by actions such as avoiding certain periods or areas where unwanted fish is occurring in higher densities. Some of the present rules are even contradictory and strict gear restrictions limit also fisheries not targeting cod (e.g. fisheries for whiting during the cod closure period have to use small-meshed clupeoid gear with a lower selectivity).

Future improvements in selectivity could be encouraged by creating a system of incentives for the desired result of fishing operations rather than by ever-increasing detail of descriptions of legal gear. This would also make any considerations of exemptions to the present regulations superfluous.

The minimum landing size presently forces fishers to discard fish which could easily be marketed: most of the undersized fish is just below MLS. The present MLS is not in alignment with the description of legal gear, which catches a significant amount of fish which cannot be landed. Further, it is almost impossible to comply with such a rule when large catches have to be processed as there is no tolerance for the amount of fish which can be landed just below MLS or which can be discarded just above MLS. An increase in CPUE can be expected with improving stocks. The quickest and most effective solution to this problem would be to impose a discard ban and abandon MLS immediately.

Options for the future

a. status quo – leave unchanged, continue amending tech regs on a very detailed level

   problems remain, but avoids the development of a market for small fish

b. abandon MLS

   abandoning MLS would mean to implement a discard ban immediately (because of the highgrading ban already in place); there is some risk that a market for small fish develops.

c. leave only measures which have proven to be successful

   intermediate solution, in some instances difficult to judge whether a measure had a positive effect or not

d. abandon most measures

   Fishery could be operated with incentives rather than rules which are difficult to enforce – if all caught fish is counted against the quota and if catch is fully documented, most rules could be abandoned. Fishers could be allowed to fish with any net, as they will have a strong interest in developing most selective gear themselves – would allow for much more creativity in the improvement of selectivity than under the present situation, much easier to control, much cheaper for community and fishery. There can however, be compliance problems in fully documenting the catches.

7.7. Conclusions of tactical approaches (regulatory framework)

Enforcement and control has clearly been improved in the years since the management plan has been implemented. It can't be demonstrated whether this improvement is directly related to the plan or caused by changes outside its control (such as efforts by the retail industry, changes in administration of member states or tie-up schemes for parts of the fishery). Illegal or unreported landings are not currently considered a problem in fisheries targeting Baltic cod, and TACs is thought to limit the fishery effectively. However, the tie-up scheme for a significant part of the fleet operating on EB cod ends at the end of 2011 so the enforcement problem might reappear. Any future plan should be able to address such changes immediately (within a year).

Effort limitations have only affected the fishery to a very limited extent, as they have restricted only a relatively small number of vessels of few specific metiers (approx 5%). This measure could be discontinued, without consequences for achieving the targets of the management plan as long as other methods suggested are effective.

Technical measures affecting the fishery, but not part of the management plan(gear and MLS), may have contributed to the improvements of selectivity. Recent changes to these measures have not been very effective and may have lead to over regulation.

Temporal or spatial closures aiming at protecting spawning aggregations of cod are in place for more than 10 years. These measures theoretically contribute to an improved recruitment; however the immediate effect has not been verified. The timing of present closures was investigated and while they were found to match the spawning period for the Eastern Baltic, to be more effective, they would need be changed, to match the spawning period for the Western Baltic.

Most of the issues raised above could be addressed with an integrated approach to the management: The main elements should be to give clear objectives and measures which are easy to follow and easy to control. Rules not contributing substantially to the objectives could be discontinued and replaced by a system of incentives for the fishery. Such a management approach is outlined as "result based management" in the EU green book on the reform of the common fisheries policy. This could work without detailed rules affecting input (e.g. effort restrictions, gear descriptions) but would be conditional on improved system to assure compliance of output metrics. Trials on a fully documented fishery within the catch quota management (also addressing the discard issue) have demonstrated that such a system can be set up in a reasonable time frame and are a good alternative to the present management framework.

8. EFFECT OF DIFFERENT PLANS ON FISHERY

The simulations have been performed with an age-structured multi-stock and multi-fleet bio-economic model which have already been published and applied for the Baltic cod stocks and fisheries (Bastardie et al. 2010a,b; Nielsen and Limborg, 2009).

The simulations cover evaluation of different management instruments such as TAC regulation under different relative annual variability constraints either alone or together with effort regulation, as well as effort regulation alone, and results-based management including TAC regulation under a catch quota system. Simulations have been performed applied for the Western Baltic cod stock (one stock) and management area in present context. This modeling is performed on a highly disaggregated seasonal and spatial scale using the spatial and seasonal explicit application of the FLR model. Incorporating the spatial scale into the more elaborated stochastic fleet-based forecast model was planned to integrate potential effects of the population dynamics and the age-specific spatial distribution of the population together with the spatial and temporal allocation of fishing effort also including the heterogeneity of fishing practices. This model has been up-dated with information from among other sources ICES WGBFAS 2011 (ICES 2011) and up-dated fisheries information from the EU STECF effort evaluation working group (see Annex 3).

The evaluations are described in detail in Annex 3 are performed and organized as follows:

- Effectiveness of effort regulation for reducing F in relation to TAC regulation
- Results based management – effectiveness of the LTMP in relation to catch quota and no discard.

8.1. Baseline

To illustrate the response of the fishery to Long Term Management Plan (LTMP) baseline runs were carried out.

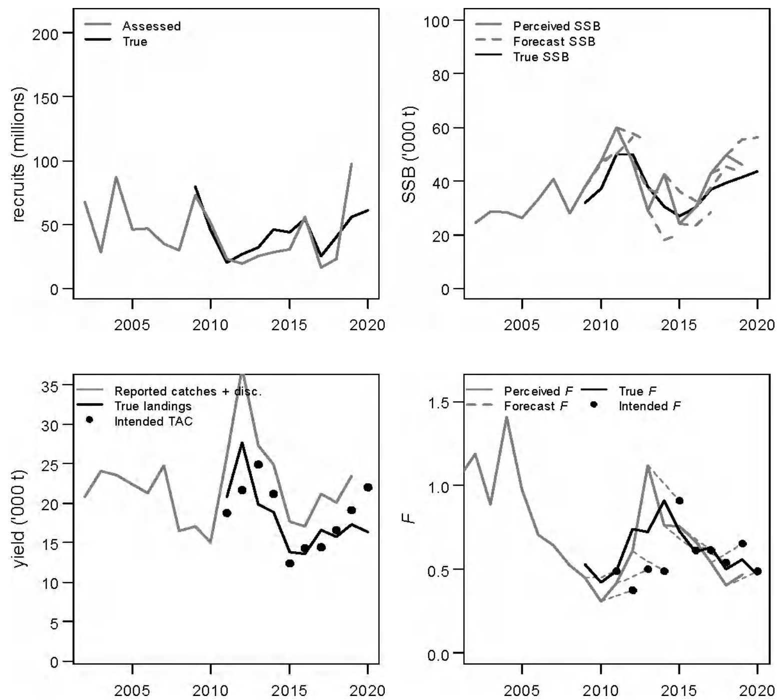


Figure 8.1 One selected run for the baseline projection of the LTMP (i.e. F reduction with TAC and effort regime) simulated with the fleet-based model.

Figure 8.1shows that the true population is impacted by the implemented TAC and effort regime with some delays while the short-term targets applying the LTMP regularly changes of direction (i.e. increase/decrease the TAC and the effort) the combination of the varying recruitment, measurement error and delays creates oscillation in individual trajectories.

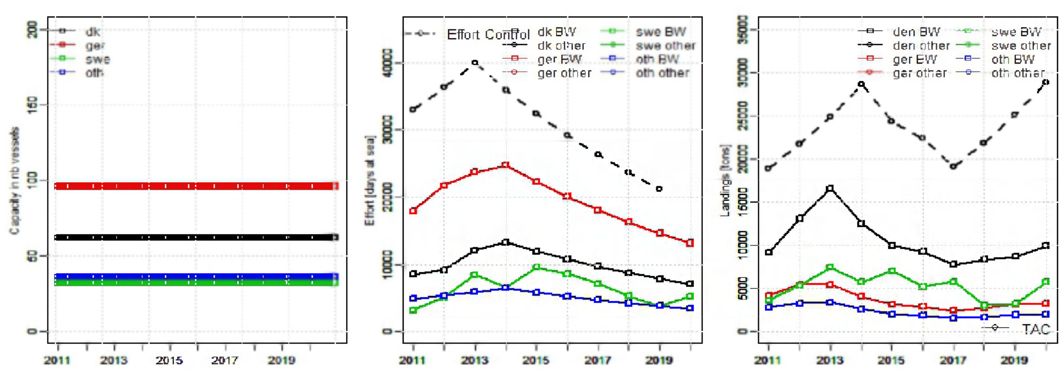


Figure 8.2 Capacity (left, i.e. given the effort in 2009 and assuming 20 days at sea for a mean vessel), total effort and effort per fleet-segment (centre), cod TAC and landings per fleet-segments (right) for one selected run (the same as previous figure) simulated with the fleet-based model.

Figure 8.1 indicates that for this given run, the effort is initially increasing as the assessed F is below the Ftarget of 0.6 and then is regularly decreasing while the F is still above the target. The effort reduction is implemented in terms of days at sea per vessel while the capacity is assumed to remain constant within the simulation. Note that the TACs are sometimes not completely taken for various reasons (given the effort some fleets segments are no longer able to catch their quotas, or the actual population does not permit the intended amount of fish to be taken, or the implementation error led to lower or higher TACs than the ones advised by the stock assessment, etc.)

Presented below are some illustrations of TAC and effort control. The elements of effort control do not relate directly to the current implementation of the management plan, as effort control is implemented differently at the vessel level with immediate effect, however, they serve to show that even with limited implementation the difference from TAC control alone are small. Figure 8.3 indicates the measurement error comparing the Operating Model, (OM) and Observation of the stock (MP). Figure 8.4 illustrates the proportion of positive and negative and positive changes by year for Western Baltic under the different recruitment assumptions. While this figure illustrates the proportion of changes it does not indicate if they are or are not in the same direction in successive years.

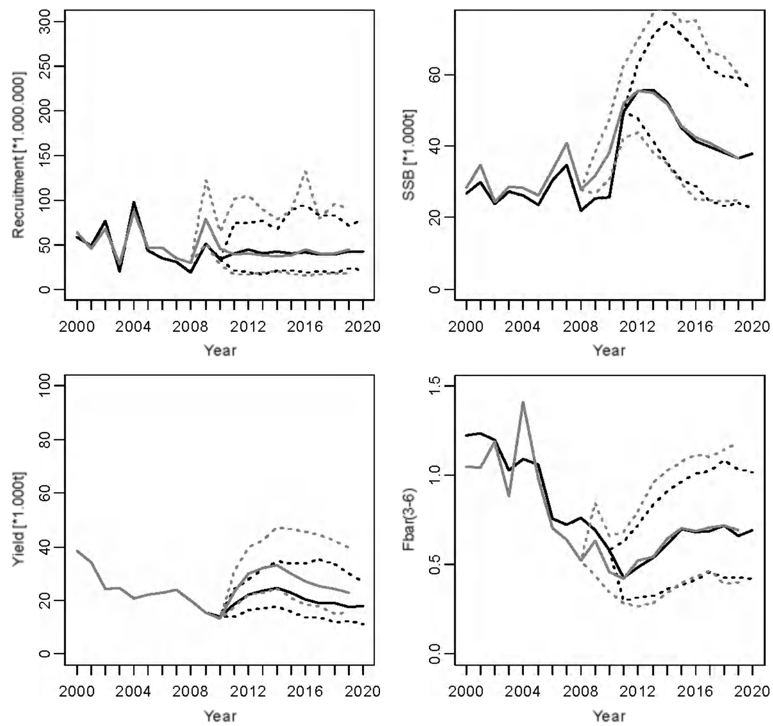


Figure 8.3 OM vs. MP for the baseline with the fleet-based model (N=100).

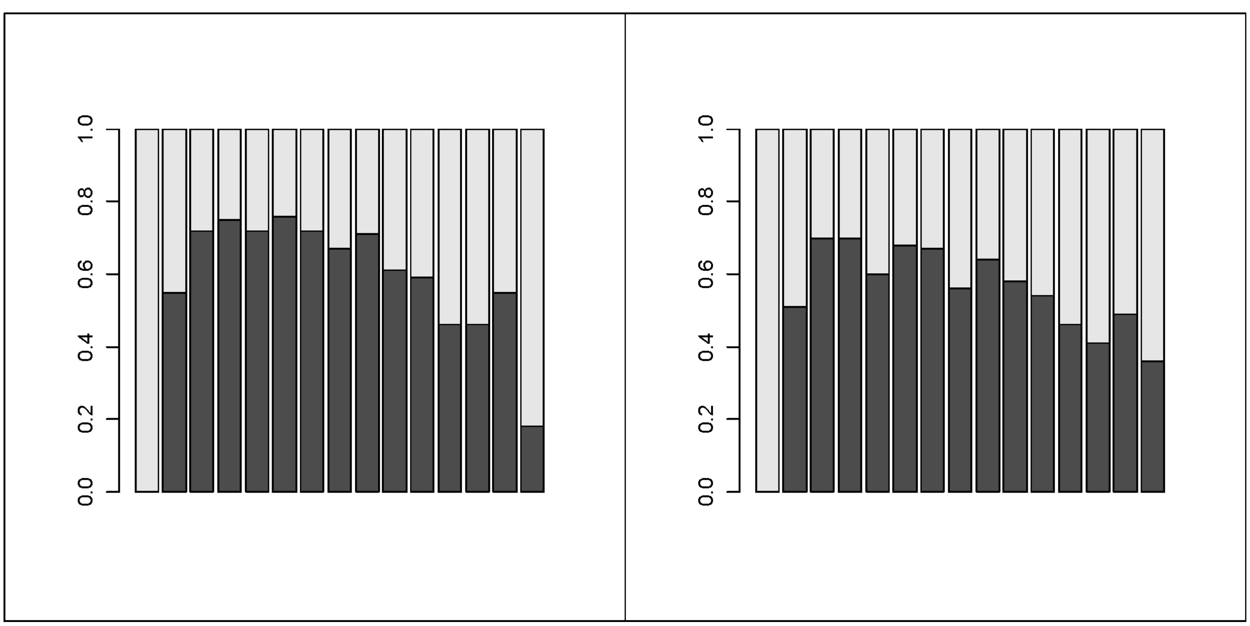


Figure 8.5 Proportion of positive (in black) and negative (in grey) Western cod TAC change from the year to the next for the baseline scenario with low recruitment (left) or low recruitment (right) regimes.

8.2. Impact of different management scenarios

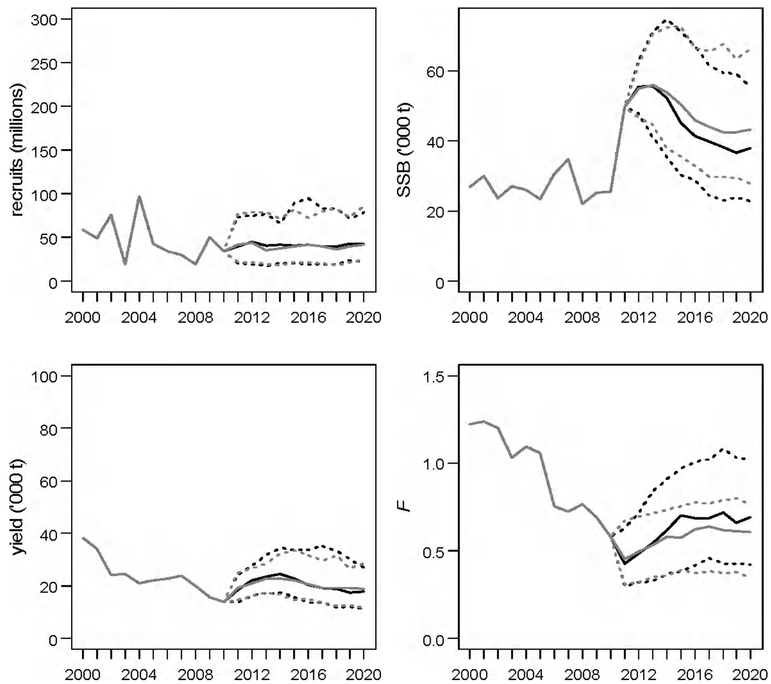


Figure 8.6 Impact evaluation of the LTMP without the effort control simulated with the fleet-based model (baseline LTMP (black) vs. TAC only (grey))

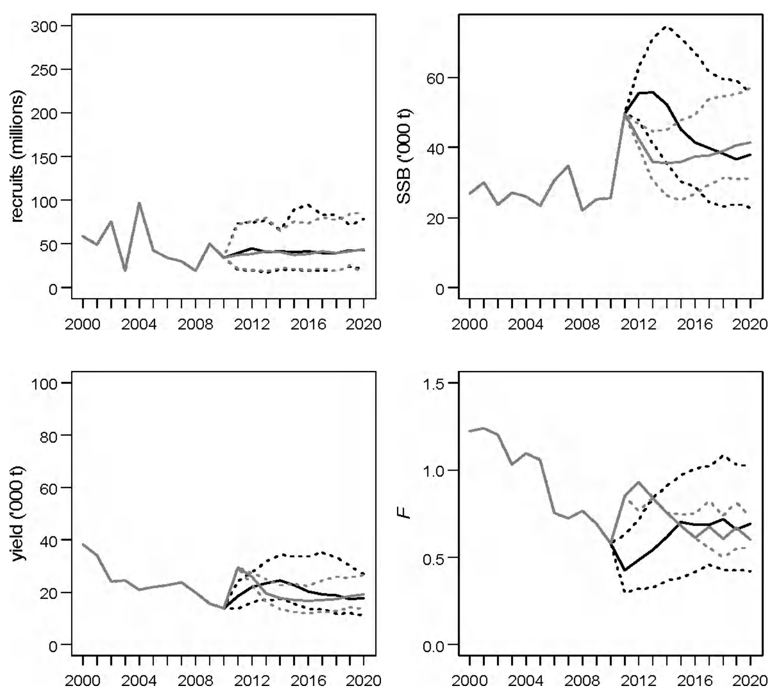


Figure 8.7 Impact evaluation of the LTMP without the TAC simulated with the fleet-based model (baseline LTMP (black) vs. Effort only (grey))

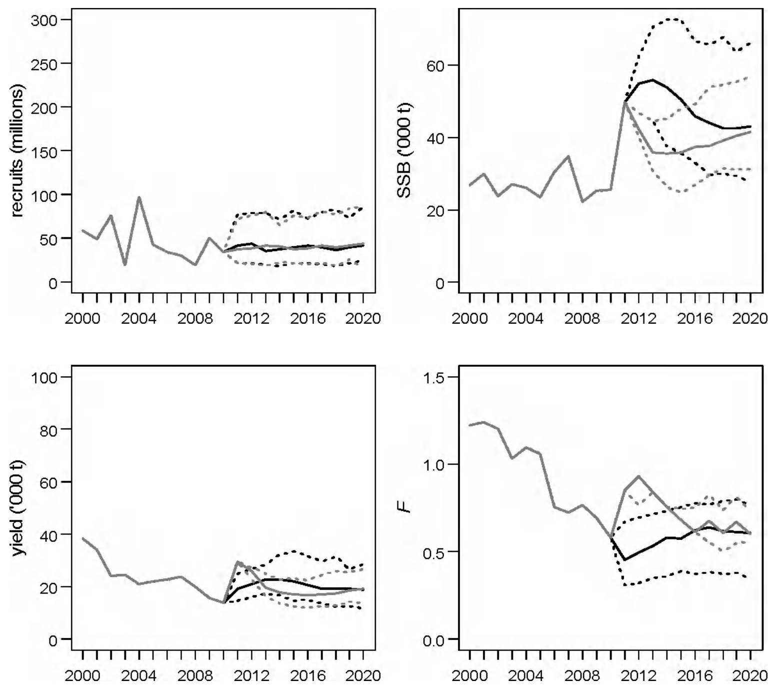


Figure 8.8 Impact evaluation with the fleet-based model of the LTMP including the TAC only (black) or including the effort control only (grey)

Without detailed vessel data for use in the model, the 10% effort reduction requested by the plan was applied as a 10% reduction of the effort to each individual vessel. This is a much more restrictive interpretation of effort control currently implemented, and is almost certain to overestimate the effectiveness of effort control.

The results indicate that the respective contribution of the TAC and the effort control to the LTMP is different in the sense that the effort control alone led to higher F and smaller SSB because of higher catches in the short term when the TAC was no longer constraining the catches (Figure 8.6-8). Additionally, for the first projected years this type of effort control could have led to increase in the total effort driven by the HCR when the assessed F was close to the 0.6 target (but just below). All in all, the simulations of combined control (i.e. TAC + effort control) appeared slightly less efficient compared to a TAC regime alone (because the simulations do not allow an increase of effort beyond the historic one while the effort regime alone allows this) but this small difference is likely to be due to the fact that the F is already close to the target of 0.6.

Previous studies (e.g. Bastardie et al., 2010b) showed that the added value of the effort control (added to the TAC regime) was to make the multi-annual plan more robust by limiting potential unexpected increase in nominal effort or catching power and prevent over-quota consequences on the stock evolution and the stock assessment procedure. However, the method tested was much more restrictive than the effort regime currently being followed (See Section 7.3.1 above). Both approaches are more restrictive than the current LTMP

Scenario testing the impact of setting a catch quota instead of the current landing quota showed no significant impact on the stochastic projections with fishing mortality still able to reach the F target at 0.6. (See Annex 3). Absence of effect on the robustness of the plan is likely to be due to the design of the simulation where the cod discard ogive has been kept constant in the projection. In practice however, such a regulatory approach may reduce the impact of fluctuating discard rates.

This evaluation reported in detail Annex 3 also includes bio-economic evaluation and cost effectiveness of effort and TAC regulation (see summary in the next section, Section 9).

9. BIO-ECONOMIC EVALUATIONS

Economic data used were taken from the 2011 fleet economics data call which is also the basis for the 2011 Annual Economic Report (AER). For the first time, transversal data had been requested for the calendar year just prior to the call and was specified at a higher disaggregation level.

The selection of fleet segments under consideration here was based upon 2009 landings data. Criteria to select fleet segments were based on the contribution to total Baltic cod catches and the relative importance of cod for the segment under consideration. This led to a selection which only partly overlapped with the one used for the LTMP evaluation in 2010 (SGMOS 10-06e), which was based upon a multiannual average. However, difference is justifiable as the differences come partly from the fleet segmentation changes from the change from DCR to DCF definitions. The new selection is more appropriate for an impact assessment which refers to the future and therefore it is more appropriate to focus on the most recent available data. The selected segments are presented in Annex 3.

Effort and landings data were collected on the lowest aggregated level available. However, allocation of annual cost data to different cost items by area/fishery at this level of disaggregation is not currently possible. Therefore it has been assumed that different fishing activities within the individual segments have similar cost structures.

It has to be pointed out that several data sets of member states and fleet segments proved to be incomplete, which considerably hampers a time series analysis. Moreover, historic comparisons have to be interpreted with caution as the definition of variables has changed with the implementation of the DCF in 2008. This is of relevance in particular for crew cost, which could contain imputed compensation of the owners labour, and for capital cost, which has been defined differently under the DCF.

9.1. Baseline

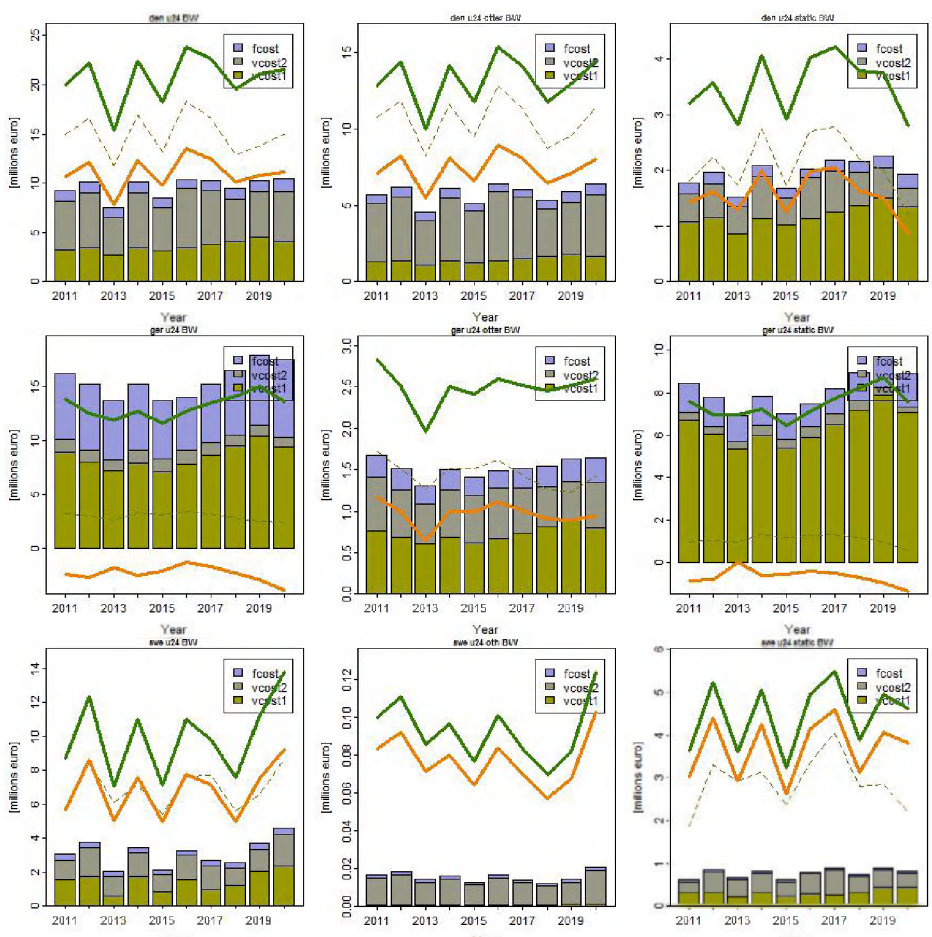


Figure 9.1.1 One selected run for the fleet-specific bioeconomic baseline projection of indicators in millions euros (green solid line: gross return from landings, green dashed line: gross return from cod landings only; orange solid line: net profit; vcost1: costs depending on effort; vcost2: costs depending on revenue; fcost: fixed costs) for selected fleet-segments under the LTMP (i.e. F reduction with TAC and effort regime) simulated with the fleet-based model for the Western Baltic area.

Assuming a Western Baltic cod price of 1.5 euro whatever the fleet segment, all fleets but ger_u24_static (German vessels less than 24 metres in size and using static gear) have positive profit and for a large part due to landings of cod. The particular case of ger_u24_static with negative profits is likely to be due to an overestimation of the variable cost depending on effort from bad estimate on fuel costs in this special case.

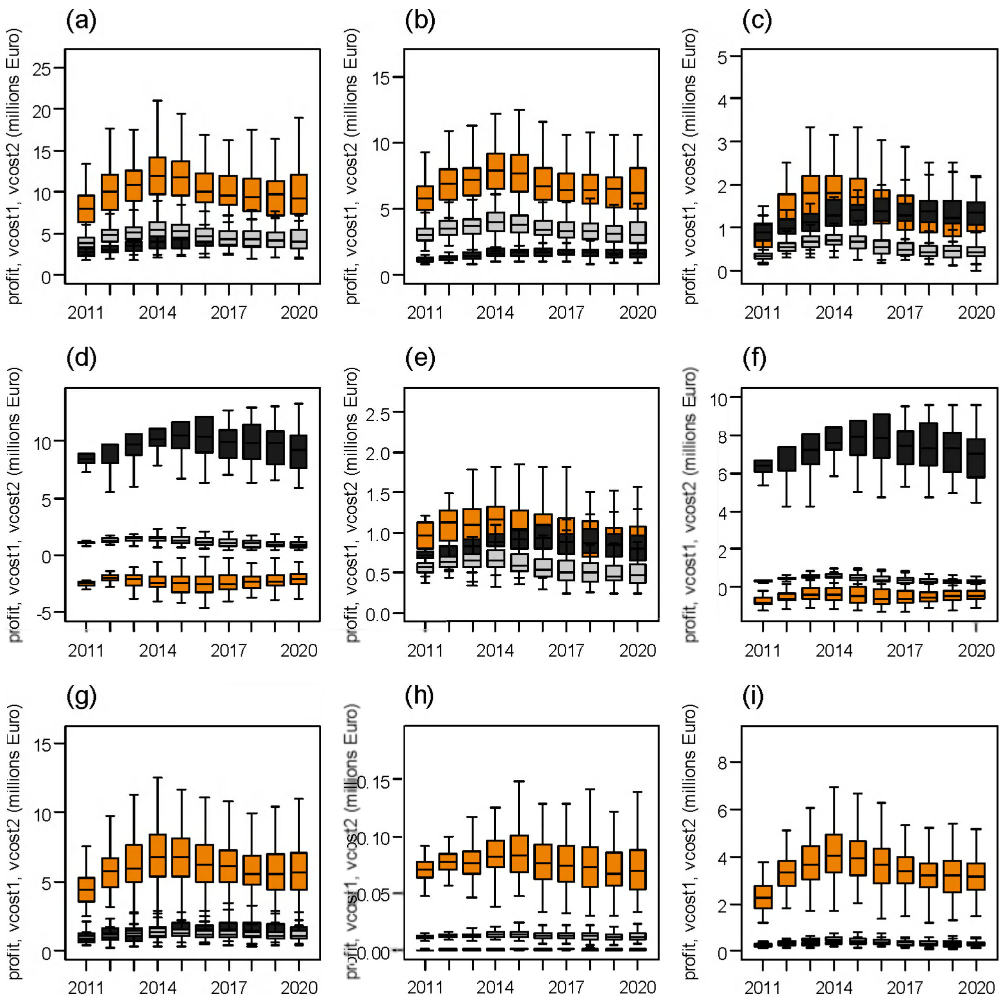


Figure 9.1.2 Box and Whiskers plots of the economic indicators in millions euro per fleet-segment (a. den_u24, b. den_u24_otter, c. den_u24_static, d. ger_u24, e. ger_u24_otter, f. ger_u24_static, g. swe_u24, h. swe_u24_oth, i.swe_u24_static) for the baseline with the fleet-based model (N=100) with, from the variable cost depending on effort (dark grey), the variable cost depending on gross revenue from landings (soft grey) and the net profit (orange). The fixed costs are not displayed for readability.

The projections assume a constant capacity in terms of number of active vessels and no dynamic reallocation of effort between fleet-segments e.g. according to their relative profits (i.e. relative effort between fleets and capacity are snapshots of the year 2009). In this context, under LTMP F reaches and is maintain at the F target = 0.6 (Section 8, effect on fishery). The results indicate that the profit is also maintained for all the different fleets participating in the fisheries. Landings could have even slightly increased in the few starting years due to a slightly lower amount of effort (and then variable costs) used to take to TAC.

9.2. Impact evaluation

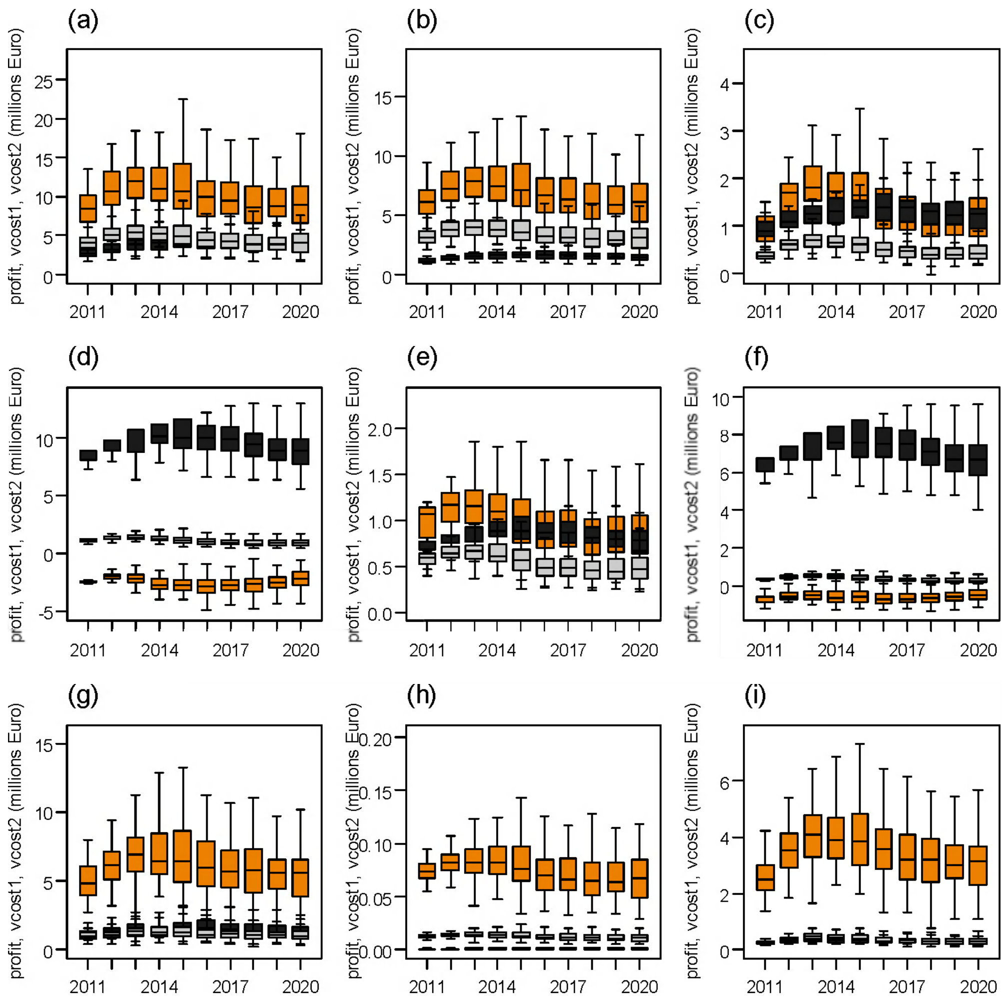


Figure 9.2.3 Box and Whiskers plots of the economic indicators in millions euro per fleet-segments with the fleet-based model for LTMP but with allowed TAC change of 30% from a year to the next.

The results indicate that given the uncertainty ranges in the projected profits, the departure of this scenario from the baseline (TAC change at 15%) is insignificant.

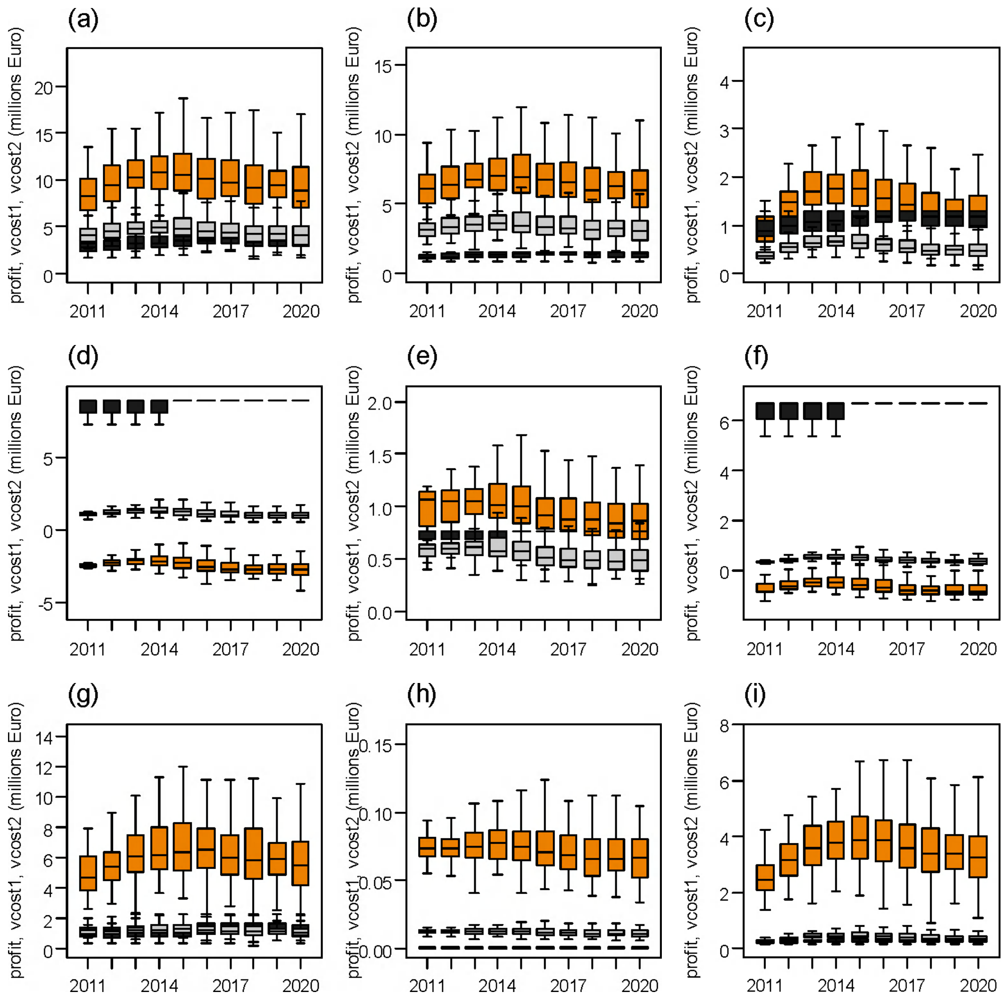


Figure 9.2.4 Box and Whiskers plots of the economic indicators in millions euro per fleet-segments with the fleet-based model for LTMP without the effort control

The results indicate no change from the baseline apart from decreased variable costs for the particular ger_u24_static fleet-segment while the outcome of this fleet cannot be considered with confidence as already stated above.

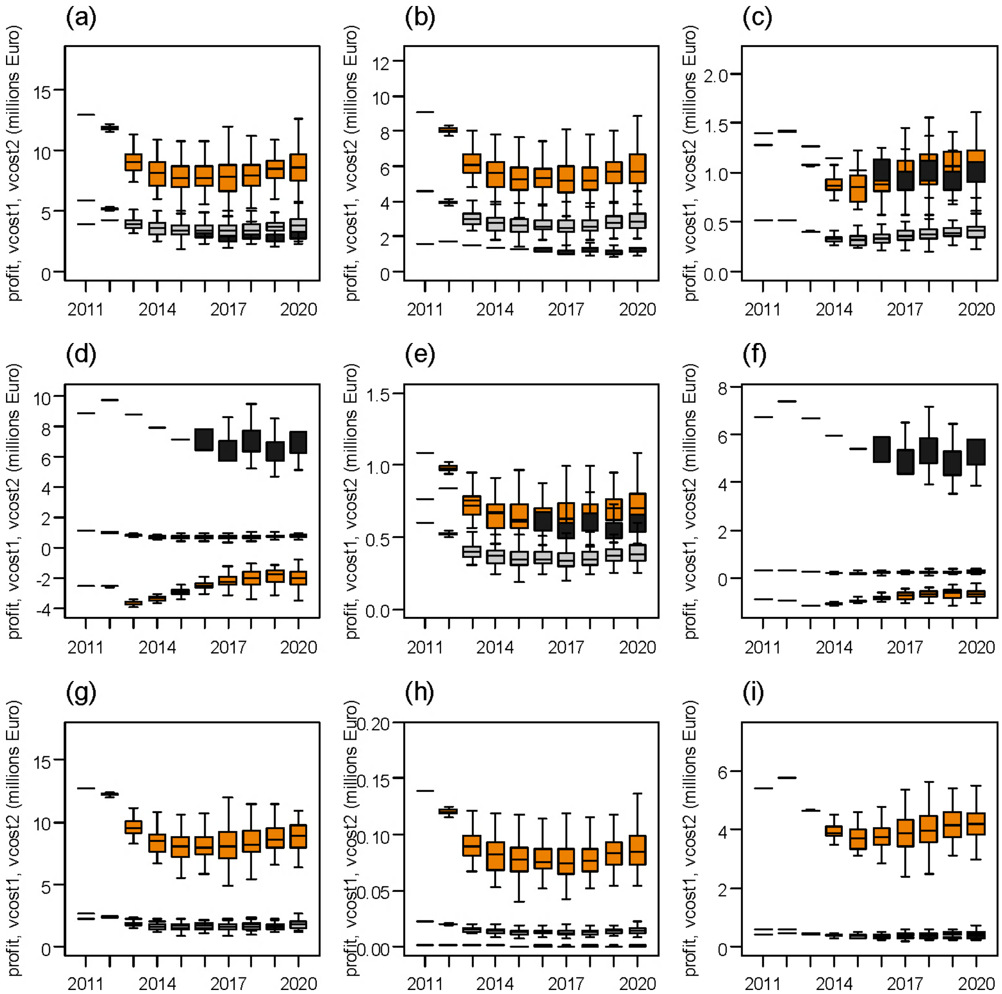


Figure 9.2.5 Box and Whiskers plots of the economic indicators in millions euro per fleet-segments with the fleet-based model for LTMP without the TAC regime

This scenario was about keeping only the effort reduction and getting rid of the landings limitation (TAC). In this case, all the fleet-segments were able to catch more than the baseline for the starting years, without putting the stock at risk (Section 8.2, effect on fishery) while the F target at 0.6 is reached. Profits were consequently higher and then stable. However, these scenarios use a different effort control model from that actually in force and assume full linkage of F and Effort.

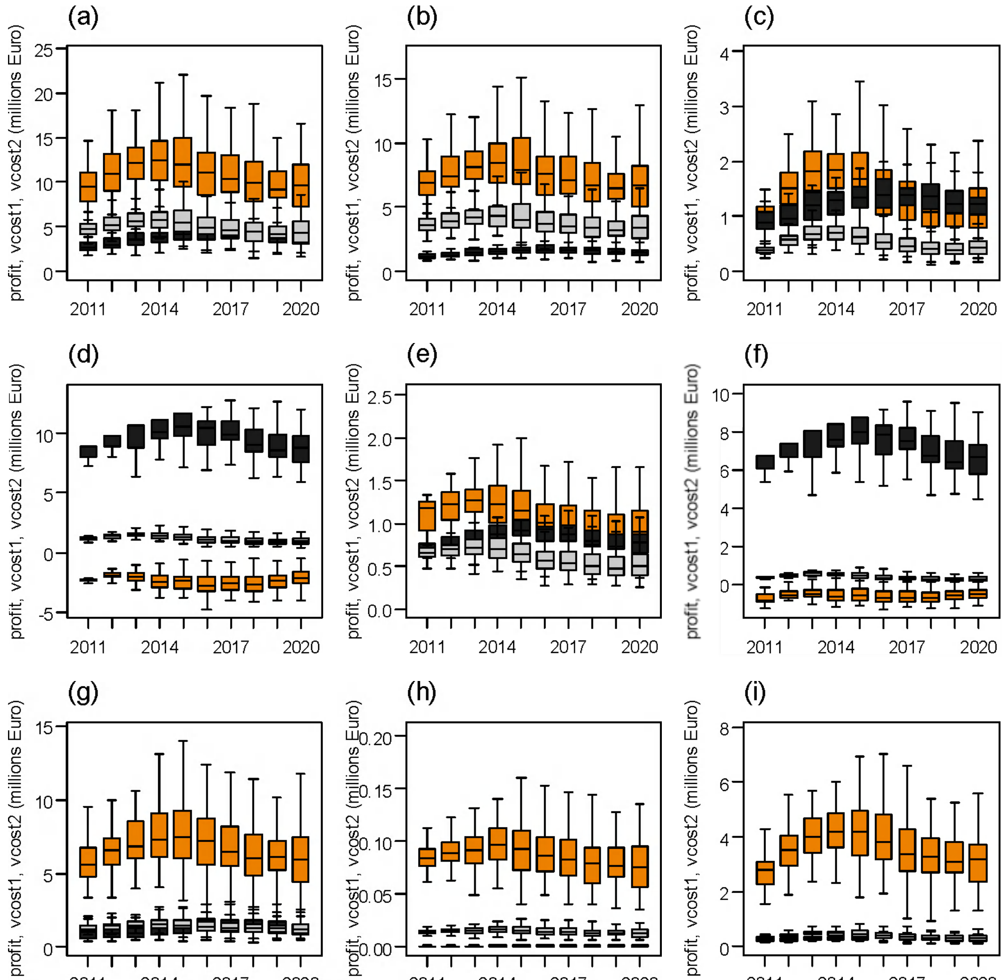


Figure 9.2.6 Box and Whiskers plots of the economic indicators in millions euro per fleet-segments with the fleet-based model for LTMP with no allowed discards + 10% TAC compensation

In agreement with the biological impact evaluation (Section 11, effect on fishery), comparing a catch quota system instead of the current landing quota system showed no significant impact on the stochastic projections of the profits. Absence of effect is likely to be due to the design of the simulation where the cod discard ogive has been actually kept constant in the projection, see Section 8.2 above.

9.3. Management of Eastern Baltic cod using a size selective harvesting: A bio-economic evaluation

The results of the simulations suggest that by using different harvest selectivity and thus changing the size range of harvested cod, we can increase the revenue of the Eastern Baltic cod fishery compared to both Fcurr and FMP while assuring sustainable high long term yield (Cardinale and Hjelm Annex 4). The reason is that both Fcurr and FMP are based on the current fishing selectivity of the fleet while we would be able to harvest a much larger biomass of cod if the average size at harvesting would have been close to its maximum growth potential (i.e. Optimum length for greatest catch, Lopt, which for Eastern Baltic cod is around 70-77 cm total length). Also, assuming a higher price per kilo for larger cod (in 2010 the price of the different commercial size categories of cod differed by 65% in the Swedish market; size-dependent price scenario), the increase in long term revenues with an Lopt strategy is even much larger than compared to any other scenario analysed here. Managing the stock according to the proposed strategy would provide a larger harvest than with the present management system and, at the same time, the stock would consist of a greater proportion of large and older individuals. Based on size-dependent price scenario, after only approximately four years, the cumulative economic revenue will be similar to the management plan regime scenario, and after five years the cumulative revenue of the Lopt management strategies will be higher than any other management scenario. On the other hand, assuming equal price for all size classes of cod, it will take about 7 years for cumulative economic revenues under a Lopt management strategy to be higher than the management plan regime scenario. It is important to notice that this obviously imply a short term loss for a period between 4-7 years but a cumulative gain in the long-term.

Conclusions to size selective harvesting

A size-selective harvesting regime will have long-term beneficial effects both on the fleet revenue and on the stock dynamics and ecosystem. A Lopt-strategy will imply that cod has spawned several times before being caught, thus counteracting the negative effects of fishing-induced trophic modifications at the ecosystem level that results from the reduction of top predator (e.g. Casini et al. 2009), including genetic selection (Hutchings 2009). It will allow the population to be more similar in size structure to an unexploited situation, where the biomass and average size of the stock is much larger than observed today, reducing variability in recruitment, unstable population dynamics and increasing the ability of the ecosystem compensate for environmental fluctuations (Anderson et al. 2008). Though it is currently not possible to estimate the impact of a strategy which implies a substantially greater SSB than would be the case under MSY at current size harvesting.

10. Potential impact and possible inclusion of additional removals; recreational fisheries and discards

Apart from the removals of the stock reported by the commercial fishery, there are two additional important sources of removals: recreational fishing and discards.

Discards are scientifically sampled for amount and composition under the EU data collection framework. ICES' estimates of discards vary between stocks and years, the latest estimate for 2010 is 9.9% for Western and 6.6% for Eastern Baltic cod. These estimated levels of discarding are currently included in the assessment and have been accounted for in the MSY evaluation in Section 6.1 Larger vessels obliged to use an electronic logbook have to report discards since 2011. Highgrading (the discarding of fish which could legally be landed) is prohibited since the beginning of 2010. It is unclear how effective this measure is; there is no reason to believe that the incentive for highgrading has been reduced. Discards play an important role in the public perception of the sustainability of fisheries, and discarding dead or dying fish is considered a waste of the resource. The European commission has put a solution of this problem high on the agenda, and it can be expected that severe measures to reduce the amount of discards or even ban discards will gradually be implemented in EU fisheries in the near future. Due to the simplicity of the Baltic ecosystem and fisheries (few target species, comparatively little unwanted bycatch, few participating nations and metiers), the Baltic might be considered an ideal test site to phase out discards.

Sampling of recreational fisher's catch is obligatory under EU law since 2003. Pilot studies indicated that, in some areas in the Baltic, the removals of cod by recreational fishers are not only significant but also highly variable (SGMOS 2010-6b), and that the partial F at age differs between recreational and commercial fisheries. These catches are currently not included in the stock assessment, as the methods of deriving the information differ largely between the different nations. The EU and ICES initiated a process to harmonize the sampling methods in 2009, and it is expected that recreational fisher's catch is included in the ICES assessment and forecast.

The regulation of recreational fisheries is very different between countries; in most countries, the level of regulation is minimal compared to that of the commercial fishery. The inclusion of recreational catch data in assessment and forecast will most likely lead to the perception of more productive cod stocks – the potential yield will increase, along with the numbers of participants in the fishery. This might call for a formal process to distribute the additional potential catch among commercial and recreational fishers, i.e. a harmonised management of the recreational fishery exploiting the stocks.

Options for the future

1. **discards**

    a. status quo – leave unchanged

    problems continue

    b. report and count all discards against the quota

    improves assessments, creates incentives to minimize discards (e.g, by applying methods to fish more selectively), requires a method of verifying compliance (such as fully documented fishery)

    c. ban discarding

    most likely option, eases control but needs a method of verifying compliance (such as fully documented fishery), easy to communicate, needs exemptions for animals with high survival rate

2. **recreational fishing**

    a. status quo – leave unchanged

    large uncertainty in assessment and forecast will remain, no additional rules and enforcement needed, cheap on the data collection side

    b. include RF catch in WB cod assessment only

    this option is already underway, will take 2-3 more yrs before WB cod RF data can be included in the assessment

    c. include RF catch in both cod assessments

    preferable option from a scientific point of view, but a lot of negotiations and harmonisation needed

    d. ideas on management of RF/process considerations

    Management of recreational fishing needs an open discussion on aims and achievable results – if variability is the main issue and not total catch, and if RF form an important part of coastal economies, RF should be limited as little as possible. Potential measures addressing these aims include the issuing of licenses, the limitations of bag limits (limit on number of fish per fisher and day), the closure of certain areas or periods. A reasonable distribution of fishing opportunities but also the appliance of common rules is also a matter of fairness among commercial and recreational fishing.

11. ENVIRONMENTAL EFFECTS OF THE OPTIONS

11.1. Evaluation of the effects of the multi-annual plan on the stocks.

Material and methods for running the forward projection are described in the related Working Document (see Annex 3). The evaluations are performed and organized as follows:

- FLR model settings in relation to Baseline (no change)
- Baseline scenario (in relation to F-target)
- Evaluation of stock mixing scenarios and migration patterns
- Discussion of management in relation to stock mixing (migration from East to West)
- Evaluation of the robustness of the LTMP to different TAC constraints
- Evaluation of robustness of the LTMP to percentage of reduction in F
- Evaluation of robustness of the LTMP to initial biomass level
- Evaluation of stock assessment model in use

11.1.1. Baseline scenario (in relation to F-target)

The baseline scenarios with different recruitment levels (medium and low recruitment for the Western Baltic cod and low and good recruitment for the Eastern Baltic cod) uses the assessment output from the SAM model with the median (while scenarios with initial stock numbers based on the SAM upper and lower confidence limits are shown in a separate section).

The baseline scenarios have an F-target of 0.6 for the Western Baltic cod and F=0.3 For the Eastern Baltic cod corresponding to present F-targets in the present EU Fisheries Management under the LTMP. Scenarios with different levels of F-target (0.6 and 0.35) for the Western Baltic cod have been evaluated in the simulations both with the stock-based and the multi-stock-multi-fleet-based version of the model, while F-target for the Eastern Baltic cod has been kept at F-target=0.3 throughout.

West / East

Baseline (green) medium recruitment vs
Baseline (red): low recruitment

Baseline (green) low recruitment vs
Baseline (red): good recruitment

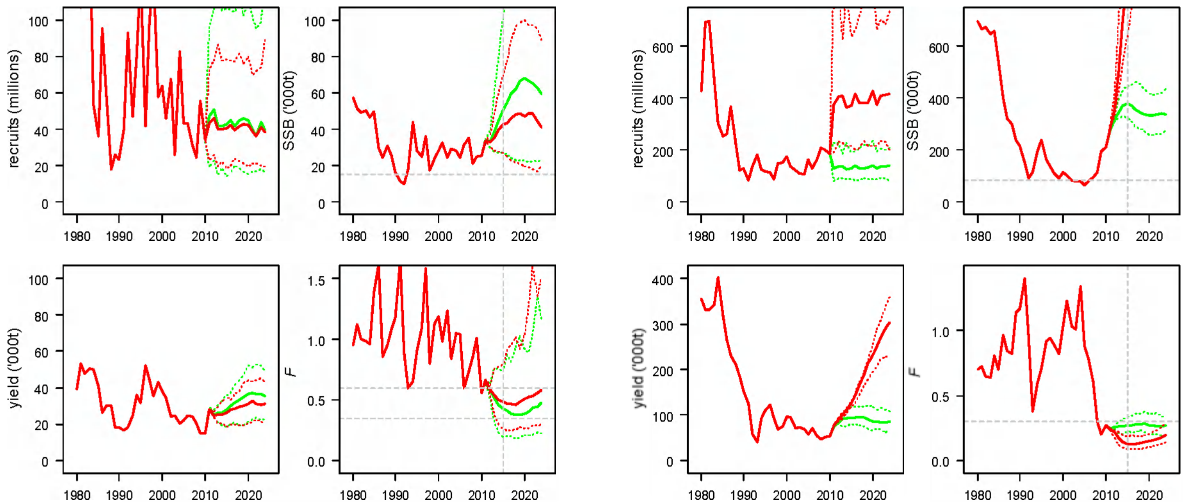


Figure 11.1 Baseline scenarios with different recruitment levels. TAC constraint 15%, reduction of F by 10%, SAM Model, F-target (west) 0.35 and 0.6, F-target (east) 0.3.

The results in Figure 11.1 indicate that for both stocks a better recruitment regime would lead to higher yield and stock levels, even to a level not previously observed for the Eastern Baltic cod under good recruitment conditions, while the F is below target F due to the annual restriction on TAC constraint.

West: Baseline (green) Ftarget = 0.6 vs
Ftarget = 0.35 (red):

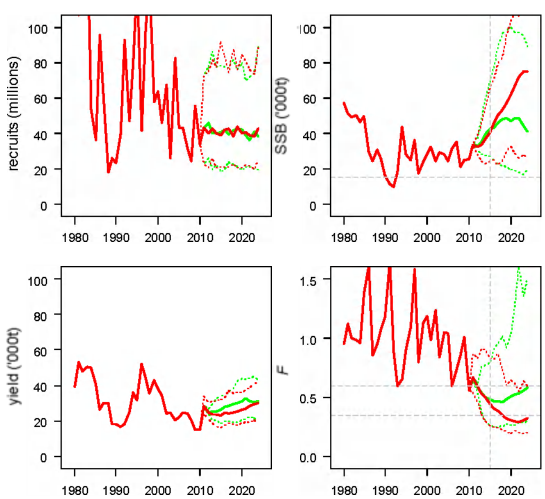


Figure 11.2 Baseline scenarios with different F-target levels. Recruitment WBC: low, TAC constraint 15%, reduction of F by 10%, SAM Model. Implementation error implCV=0.1.

The results indicate that a F target of 0.6 enable the stock to recover to the historical high level with a high certainty while a Ftarget at 0.35 could led to even higher SSB while the median yield is lower initially in this last case. The results indicate that with an F-target of 0.35 the SSB will increase to levels well beyond historic levels, though these levels are all associated with exploitation at relatively high F.

West / East

Baseline (green) vs implementation variability 0 (red): implementation variability Cv=0.1

Baseline (green) vs implementation variability 0 (red): implementation variability Cv=0.1

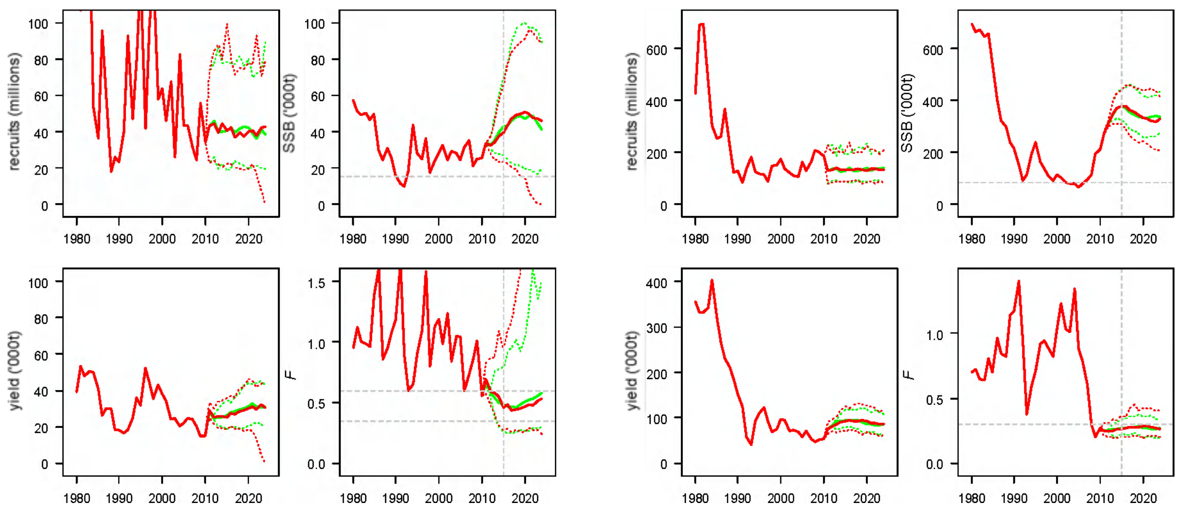


Figure 11.3 Baseline scenarios with and without implementation CVs. F-target levels: 0.6 (WBC) and 0.3 (EBC). Recruitment WBC: low and EBC: good/low, TAC constraint 15%, reduction of F by 10%, SAM Model.

The results in Figure 11.3 indicate that for the Western Baltic cod, the implementation error increased the uncertainties of future stock projection while the success of the plan is not changed in average (however with the higher target F=0.6 in these simulations a few trajectories have led to failure, due to very high implemented F (>1.2)). This problem does not occur for the Eastern Baltic cod with the lower target level of 0.3 at least not at the tested level of implementation error of CV=0.1.

11.1.2. Evaluation of Stock mixing scenarios and migration patterns

The sensitivity of the management plan has been evaluated to different levels of stock mixing and migration between the two Baltic cod stocks. Different scenarios of mixing/migration have been applied based partly on information from recent scientific reviewing of literature and tagging studies (e.g. Hussy, 2011, in press IJMS) as well as based on information from recent preliminary analyses of frequency distributions of otolith types by area (ICES WGBFAS 2011).

The fishing mortality corresponding to maximum sustainable yield (FMSY) that is currently defined by ICES is substantially lower than the management plan target, and would correspond to a very different management advice.

Due to mixing between the Eastern and Western Baltic cod stocks, which at present is not taken into account in stocks assessments the size of the underlying populations is uncertain. Such mixing will affect directly the estimates of stock biomasses and fishing mortalities in the assessments and forecasts, and can if significant result in a wrong perception of stock level, exploitation pattern and level as well as recruitment. Section 6.1 evaluated Fmsy targets for Eastern and Western Baltic cod, and concluded the F targets are similar (differing only in selection pattern and age range). S-R evaluations supporting this indicate that the fishing mortality associated with collapse (the slope of the S-R function to the origin) is probably similar for both stocks. This implies that although migration may imply that biomasses may be incorrectly estimated and distorted by migration the use of a similar F target would diminish the effect of mis-management due to migration. If F targets for the two areas are substantially different as is currently the case distortion of F advice due to migration is likely to be more sever.

The Eastern and Western Baltic cod stocks have historically been assessed separately but has been managed as a single stock under a common TAC. ICES has continuously advised that the two stocks should be managed separately to allow stock specific regulation measures be implemented differently in the two areas. This measure was fully implemented for the first time in 2005.

Mixing of stocks in the Eastern and Western Baltic is taking place. There are recent indications that the Eastern component in the Western Baltic area is important (maybe 20-30%), earlier estimates when the Eastern stock was smaller were nearer 10%. The stock size of Eastern Baltic cod has increased in recent years, although the oxygen conditions in north-eastern areas in the Baltic are indicated to be poor (ICES, 2011). Thus, the expansion of cod to north-eastern areas, which took place in former times with high eastern Baltic stock size, may be prevented in present time due to hydrographic conditions. In previous decades, the volume of water with anoxic or hypoxic conditions has also been relatively large, for example in the 1980s, though not as pronounced as in recent years (ICES, 2011). The fishery in the Western Baltic is currently taking place mainly in SD 24, with intensive fishery close to the border to SD 25. The proportion of SD 24 in cod landings in the Western Baltic is currently among the highest observed in the entire time series from 1965-2010 (ICES, 2011). The only period observed in the past when the proportion of cod landings in SD 24 was at a similar high level was in mid-1980s. In this period, cod in the eastern Baltic was also at a high level, while the hydrographic conditions in the central Baltic became poorer. This situation is relatively similar to the recent years. (ICES, 2011). Thus, it could be hypothesized that the proportion of Eastern stock component in the Western Baltic area is increasing in situations when the Eastern stock is high and hydrographic conditions in the central Baltic are poor which might prevent stock expansion to the northeastern Baltic. In such a situation, migration to the Western Baltic area could be expected. (ICES, 2011).

The proportion of cod in the Western Baltic area, potentially originating from the Eastern Baltic, was preliminary investigated in 2010 based on ICES and EU EWG work using Danish otolith samples from SD 24, in 2 areas in the western Baltic 1) close to the border to SD 25 and 2) in western part of SD 22. The otoliths of cod belonging to the Western stock are generally considered to be easier to read, whereas it is considered to be difficult to read the otoliths of the Eastern Baltic cod. In Danish samples, the classifications from A to D relate to the degree of difficulty in age-reading a particular otolith. The categories A and B refer to easily readable otoliths, the categories C and D indicate that a particular otolith is difficult to age-read, which might indicate that a particular individual is originating from the Eastern stock. The proportion of otoliths classified as difficult to read (C and D) in ICES square 38G4 (SD 24, close to the border to SD 25) was between 20 and 40 percent in 2010 (Table 11.1), and was generally higher for older ages compared to the younger age-groups. For comparison, in ICES square 38G0 (SD 22), the proportion of otoliths which were classified as difficult to read was around 10 percent. These results are, however, uncertain as they are based on these initial pilot investigations only using a limited material and the types of otoliths are only indicating the stock affiliation. These mixing rates which are higher than those previously reported in Table 11.3 below which occurred at a time the Eastern stock was smaller. They also do not account for any subsequent changes in stock size.

Table 11.1. The number of otoliths in Danish samples from ICES squares 38G4 and 38G0 and the proportion of otoliths classified as difficult to read (C+D), which is generally characteristic for otoliths originating from the eastern Baltic.

ICES square 38G4

Age	Otolith index A	B	C	D	Total	Proportion of C+D
2	18	20	9	1	48	0.21
3	44	82	29	8	163	0.23
4	47	161	73	18	299	0.30
5	9	84	44	11	148	0.37
6	7	23	14	3	47	0.36
7	2	20	9	1	32	0.31

ICES square 38G0

Age	Otolith index A	B	C	D	Total	Proportion of C+D
1	96	12			108	0.00
2	103	52	13	4	172	0.10
3	45	49	19	1	114	0.18
4	26	19	6		51	0.12
5	9	18	2		29	0.07
6	3	5			8	0.00

The proportions in Table 11.1 have been converted into the proportion of eastern Baltic cod by age migrating into the western Baltic by using the proportion of stock numbers at age in SD22-24 and SD25-32, respectively, from the ICES WGBFAS 2011 assessment to calculate this migration when applying the above proportions. The resulting migration pattern evaluated in the first scenario is presented in Table 11.2 below.

Table 11.2 Eastern Baltic cod migration ogive calculated from the assumed proportion of Eastern cod residing within the Western Baltic and the Ns at age from the last WGBFAS 2011 assessment.

Age	N_2010 wcod	Proportion of ecod within wcod	N_2010 ecod	
2	18732	0.23	198515	0.022
3	14945	0.23	159593	0.022
4	9757	0.23	114233	0.020
5	3033	0.35	56103	0.019
6	802	0.35	17910	0.016
7	321	0.35	8745	0.013

Another scenario of migration rates between SD24 and SD25 has been evaluated with estimations based on indications in:

- STECF report "Report of the Sub Group on Management Objectives and Strategies (SGMOS 10-06). Part e) Evaluation of multi-annual plan for Baltic cod", Figure K.3
- Bleil and Oeberst (2004) Comparison of spawning activities in the mixing area of both the Baltic cod stocks, Arkona Sea (ICES Sub-division 24), and the adjacent areas in the recent years. ICES C.M. 2004/L:08
- See also Hussy (accepted, 2011).

The results of this analysis are shown in Table 11.3.

Table 11.3 Estimates indicate the percentage contribution of one stock to the other, i.e. a "0.1" for East to West means, that 10% of the Western stock which originally come from the East.

Age class	East to West	West to East
0	0.100	0
1	0.100	0
2	0.092	0.008
3	0.092	0.008
4	0.092	0.008
5	0.092	0.008
6	0.092	0.008
7	0.092	0.008

This estimation of migration rates is based on the assumption that spawning time is stock specific. Thus, the percentage of the maturity patterns in March/April (Western) and June (Eastern) represents the component of one stock in the others management area. This total percentage was divided equally between age classes.

These estimates are, however, also uncertain and associated with a series of problems:

- It is questionable whether spawning time is in fact genetically determined. Even in genetically distinct stocks of e.g. herring, it is well known that environmental conditions and behavior have a huge impact on timing.
- Feeding migrations out of the spawning areas are not accounted for, thus the migration rates may be overestimated
- Not possible to separate immature/resting/spent individuals, which may lead to underestimation of migration
- Juveniles (age groups 0 and 1): This is just an assumption, based on the probability that juveniles originating from Eastern parents, but spawned in the West, probably stay in the West. But a portion of these may be transported back to the Bornholm sea as eggs/larvae

Similar to the proportions in Table 11.1, then the proportions in Table 11.3 have been converted into the proportion of eastern Baltic cod by age migrating into the western Baltic by using the proportion of stock numbers at age in SD22-24 and SD25-32, respectively, from the ICES WGBFAS 2011 assessment to calculate this migration when applying the above proportions. The resulting migration pattern evaluated in this scenario is presented in Table 11.4 below.

Table 11.4. Eastern Baltic cod migration ogive calculated from the proportion documented in the Table 11.3 of east cod residing within the West Baltic and the Ns at age from the last WGBFAS 2011 assessment.

Age	N_2010	Proportion of	N_2010 ecod

	wcod	ecod within wcod		
2	18732	0.092	198515	0.0087
3	14945	0.092	159593	0.0086
4	9757	0.092	114233	0.0079
5	3033	0.092	56103	0.0050
6	802	0.092	17910	0.0041
7	321	0.092	8745	0.0034

Preliminary simulations have been performed with these two migration scenarios (one from literature review and one from otolith analyses) compared to the initial one performed and presented under SGMOS 10-06. These evaluations of the impact of migration are based on current area based stock assessments, but imposing a switch to migration occurring from the current time. Thus they impose a biological shift in 2011, which may not be realistic. There is evidence that this technical problem is not a particular issue for the simulations of Eastern Baltic cod where the proportions migrating are small, (Table 11,2 and 11.4) but may be a problem for simulations for the Western Baltic cod in the case when migration proportion is higher (Table 11.2). In order to test the management implications it will be necessary to carry bout more complex simulations which involves:-

postulating historic migration rates,
generate underlying S-R models, that conform to these rates
run these models for a time period to obtain a state of stock and necessary tuning indices for assessment,
then impose management
and test the consequences of management scenarios relying on area assessments
or separating catch to give assessments of true stocks.

This approach would allow testing of methods that use either area based assessments, separate stock assessments using estimated migration to apportion catch and varying levels of migration. The current evaluations which include the additional problem of a discontinuity in the simulations suggest that rates below 10% are probably not a problem for management, and that management of the larger stock is not adversely affected. However, it would be preferable to check this fully. Rates above 10% may have consequences for Western Baltic cod LTMP. However, it would be preferable to check this fully possibly also taking account changed multi-species interactions according to changed stock levels (see under section 11.2). Such an approach could also be used to test for robustness to variability in migration rates.

An alternative more complex approach would involve simultaneous stock assessment and migration estimation. It is considered that such added complexity is probably not necessary to evaluate different management scenarios.

11.1.3. Evaluation of robustness of the LTMP to different TAC constraints

Here an evaluation of robustness of the management plan to different TAC constraints has been made with respect to influence of TAC constraints in change of TAC (established for economic reasons) with respect to the regulation. Different simulation scenarios are presented for release of different TAC constraints (15%, 20%, 30%). Several questions are addressed in this context: i) Given change of constraints under the situations of different biomass levels, how robust are the constraints in relation to high or low initial biomass? ii) Should a TAC constraint be biomass level dependent? iii) How often are larger increases followed quickly by declines in stock given different constraints (does it occur at all?).

According to the current LTMP: TAC constraints are excluded when $F<0.6$ for eastern cod and $F<1.0$ for western cod.

West/ East

Change in interannual % constraint on TAC 15% (green) 10% (red) 30% (blue):

Change in interannual % constraint on TAC 15% (green) 10% (red) 30% (blue):

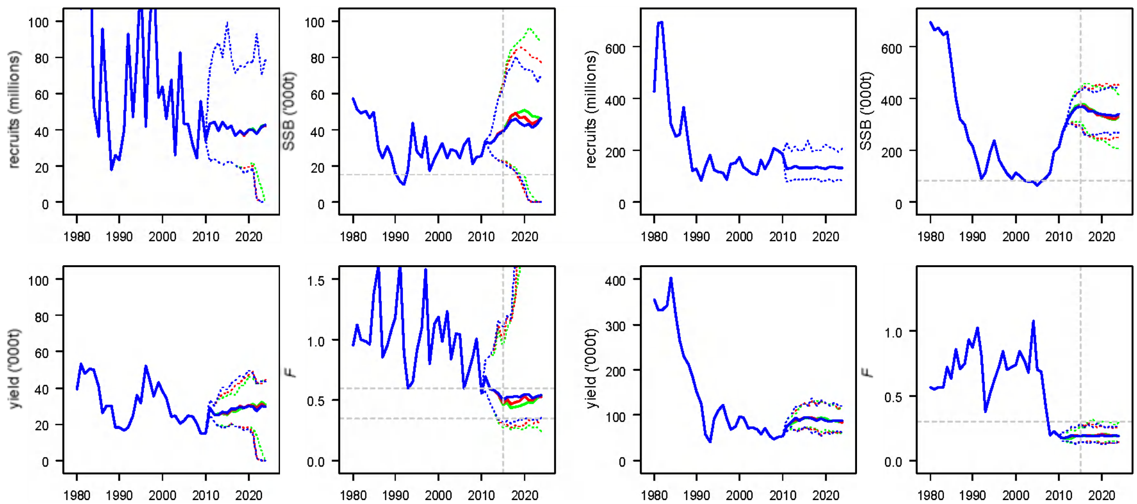


Figure 11.4 Impact evaluation of different TAC constraints with scenarios of different constraint levels. Recruitment WBC: low and EBC: low, F-reduction of 10%, Impl.CV.=0.1, SAM Model.

The results in Figure 11.4 indicate that the choice of the amplitude of the TAC change from a year to the next had almost no effect in the simulations for both stocks.

West: Change in interannual % constraint on TAC
15% (green) 10% (red) 30% (blue):
F target at 0.35

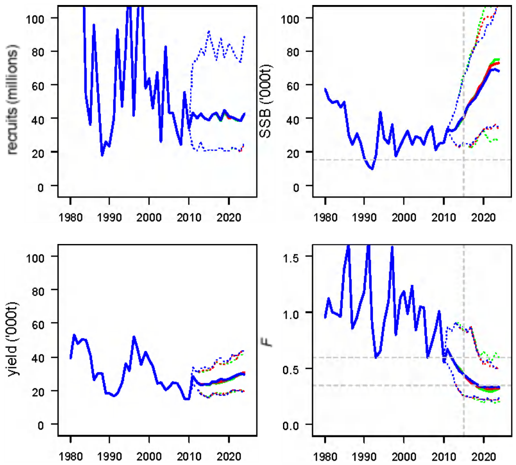


Figure 11.5 Impact evaluation of different TAC constraints with scenarios of different constraint levels including migration. Recruitment WBC: low and EBC: low, SAM Model, F-reduction by 10%, Impl.CV=0.1, stock coupled model.

The results in Figure 11.5 indicate that the various tested TAC changes for the Western Baltic cod stock are rather insensitive to the different tested F target levels, but Western stock SSB recovers and rises above recent historic sizes due to lower exploitation levels now with no risk of stock collapse.

11.1.4. Evaluation of robustness of the LTMP to percentage of reduction in F

The sensitivity of the management plan has been evaluated in relation to different levels of reductions in fishing mortality. Different scenarios of F-reduction covering status quo (0% reduction), 10% F-reduction, and 15% F-reduction have been tested with respect to robustness of the LTMP.

West
base model Change in % F reduction ...
0% (red), 10%(green) and 15% (blue)

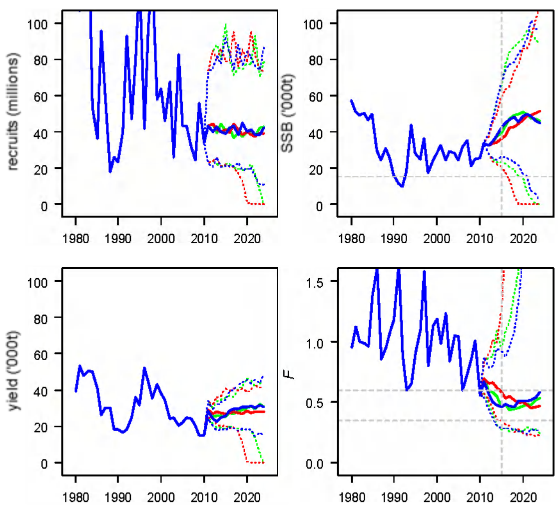


Figure 11.6 Impact evaluation of different reduction levels in F. Recruitment WBC: low TAC constraint 15%, SAM Model, F-reduction by 0% (in red), 10% (in green, as the LTMP), 15% (in blue), Impl.CV=0.1, stock coupled model. .

The results in Figure 11.6 indicate that compared to the baseline at 10% reduction in F every year when setting the next TAC, a F reduction of 15% had a minor impact by slightly reducing the uncertainties around the median projection, but mainly due to larger decrease in F than necessary. The status quo scenario, i.e. 0% decrease in F still led to a decreased F which might be artificial in the sense that few failures led to 0 catch trajectories then lowering down the median, but with a wider range of uncertainties.

11.1.5. Evaluation of robustness of the LTMP to initial biomass level

The management evaluation scenarios here evaluate the robustness of the LTMP to high or low initial biomass levels for the two Baltic cod stocks according to the upper and lower confidence intervals of the SAM assessment model used by ICES WGBFAS (ICES, 2011).

West/ East

(green) Starting values SAM upper 95% CI
(red) Staring values SAM lower 95% CI

(green) Starting values SAM upper 95% CI
(red) Staring values SAM lower 95% CI

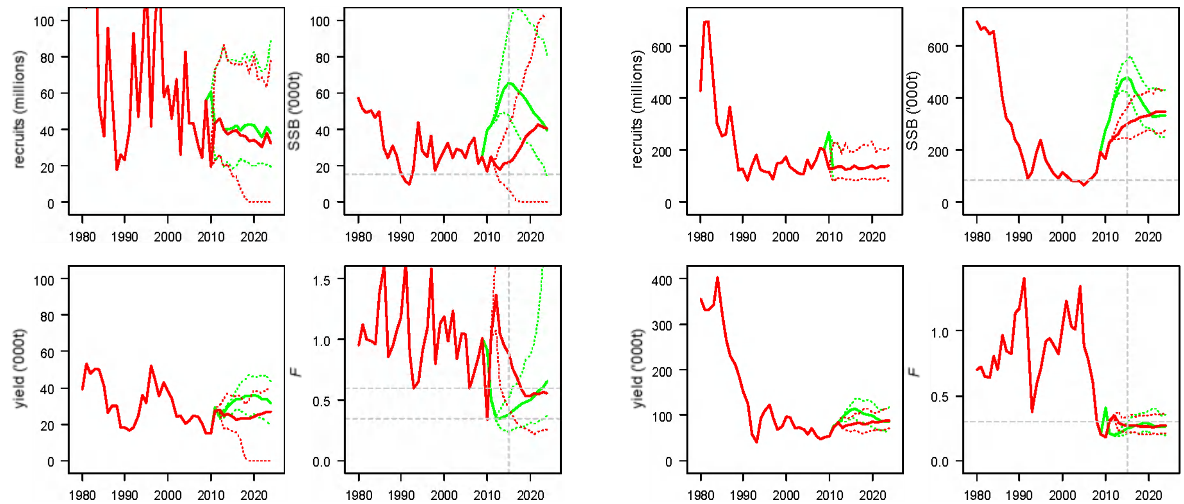


Figure 11.7 Impact evaluation of influence of different initial stock biomasses. Recruitment WBC: low and EBC: low, TAC constraint 15%, SAM Model, F-reduction by 10%.

The results in Figure 11.7 indicate that the effect of starting population appears significant for both stocks and especially for the Western Baltic cod stock. For the latter stock, due to the higher starting F unsuccessful trajectories when using the lower bound of the 95% confidence interval (CI) given by the SAM estimates (based on 2SD from the mean) led to very high Fs which lowered down the stocks and sometimes made the model unable to solve the TAC equation (the 0 catch trajectories). For the Eastern F remains close to target and probability of stock collapse is negligible.

11.1.6. Evaluation of the stock assessment model in use

The XSA model is not in use for the Western Baltic cod since 2010 as the SAM is now the official assessment model for estimating the population. By contrast the XSA is still the reference for the Eastern Baltic cod while SAM is given as secondary assessment. The robustness of the LTMP is tested against this two assessment models, albeit the XSA model is run here without shrinkage on F which is not the current setting in the WGBFAS (i.e. fse=0.75).

West/ East

(green) SAM assessment model
(red) : XSA assessment no shrinkage

(green) SAM assessment model
(red) : XSA assessment no shrinkage

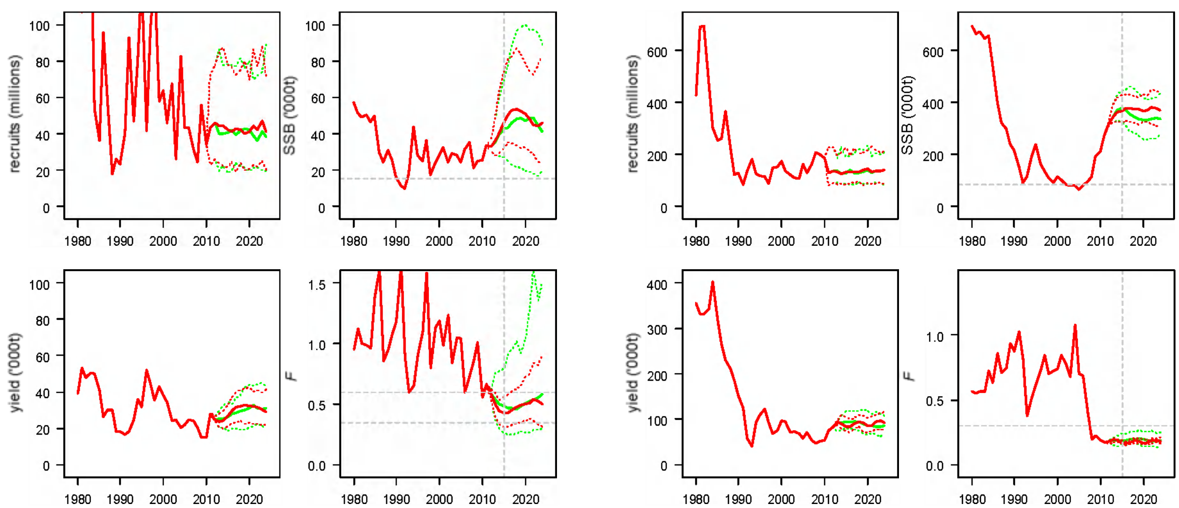


Figure 11.12 Impact evaluation of use of different stock assessment models. Recruitment WBC: low and EBC: low, TAC constraint 15%, XSA Model with no shrinkage on F, F-reduction by 10%.

The results in Figure 11.12 indicate that the effect of using the XSA model instead of the SAM model is minor and mainly consists of reducing the uncertainties of the projection, providing that the shrinkage on F is not in use.

11.2. Evaluation of the effects of the multi-annual plan on the ecosystem.

Currently no fully valid evaluations of interactions with other species are available. The evaluations reported in Annex 3 to this report are of limited scope, as similar to the migration scenarios, they introduce biological discontinuity between historic and projected parts of the evaluation. There is a need to develop new models to evaluate the consequences of the species dependent interactions, and their uncertainty and variability into the future.

More data (i.e. multi-species interaction data in the Western Baltic Sea) than available in present context, as well as additional preparatory work is required before this type of model can be used within MSE of the type used here, to evaluate the consequences of management actions.

12. Social and Economic Effects of the Plan

Table 12.1 summarises fleet dependence on cod. It contains data for unclustered segments. Table 12.2 summarises the economic status by fleet in 2009 on the basis of clustered segments as the evaluation of the Baltic cod LTMP also contained the clustered versions due to its reference to years for which only that type of clustered segmentation was provided. These data had been used as input for the bioeconomic modelling in Section 9.

Data were provided and therefore analysed only on a fleet segment basis. As in previous reports it has to be pointed out that it would be more meaningful to analyse economic data from groups of vessels which are actually involved in the relevant fisheries. However, this requires a different approach based on the analysis of individual vessel data which can only be performed if member states are able to release anonymized individual boat data.

With respect to social and economic effects of the plan it has to be born in mind that, according to statements from stakeholders, the potential economic impact of the Baltic cod management plan, since its implementation, has been distorted by external effects, primarily the drop in sales prices. The decrease in price has been partly attributed to campaigns which criticised cod for being unsustainably exploited, while substitutes (e.g. pangasius) were being declared sustainable.

A major economic benefit from the cod management plan is the decreased uncertainty in quota, with reduced fluctuations. Potential consequences are a higher willingness amongst fishermen to invest in their vessels and a less restrictive loan policy at the money market. These effects are definitely not reflected in short term time series available for this evaluation.

Table 12.1. Cod dependency of selected fleets. Based on a cut off of 10% of catch by value for Baltic cod, Representing 84% of total catch of cod in the Baltic.

Country	Gear	Vessel length	Weight of Landings (kg) Total	Weight of Landings /COD (kg) Baltic	Baltic COD/ Total	Weight of Landings / COD (kg) Baltic 25-32	Weight of Landings / COD (kg) Baltic 22-24	Baltic 22-24 COD/Total COD	Baltic 25-32 COD/Total COD
DEU	DTS	VL1218	6713756	1406703	21%	497490	909213	65%	35%
DNK	PGP	VL0010	4650886	1706729	37%	629526	1077203	53%	31%
DNK	PMP	VL1218	4743615	939936	20%	355708	584229	52%	31%
LTU	DTS	VL2440	2499164	2029525	81%	2029525	0	0%	100%
LVA	DFN	VL2440	2335307	2331037	100%	2308322	22715	1%	99%
SWE	DTS	VL2440	8193858	2550312	31%	2349169	201143	8%	89%
POL	DFN	VL1218	1898429	1580380	83%	1360264	220116	14%	86%
POL	PG	VL1012	3171725	1468314	46%	1263807	204507	14%	86%
POL	DTS	VL1218	6955159	2716854	39%	2338449	378404	14%	86%
POL	PG	VL0010	8327769	2204031	26%	1897053	306978	14%	86%
POL	DTS	VL1824	4765533	1198592	25%	1031652	166940	14%	86%
POL	DTS	VL2440	4917166	977275	20%	841160	136115	14%	86%
SWE	DTS	VL1824	15359519	3739667	24%	3330438	409229	10%	85%
SWE	DTS-PS	VL1218	8510694	1712412	20%	1472468	239944	13%	79%
DNK	TM	VL2440	28295313	2317136	8%	1893898	423239	17%	74%
SWE	PG	VL0010	3177449	1238505	39%	916166	322339	25%	72%
DEU	DTS	VL24XX	21820221	1664974	8%	1104481	560493	33%	65%
DNK	PMP	VL1012	1239641	771528	62%	517409	254119	32%	64%
SWE	PG	VL1012	3521714	1990961	57%	1307865	683096	34%	64%
DEU	DTS	VL1824	7008134	2576356	37%	1511675	1064681	41%	58%
DNK	PGP	VL1012	2112914	1052692	50%	487871	564821	48%	41%
DNK	DTS	VL1218	31610078	5874715	19%	2715893	3158822	48%	41%
DNK	DTS	VL1824	23599881	2579130	11%	1268121	1311009	37%	36%

Table 12.2 Economic performance of fleet segments in 2009

	Characteristics of fleet segments selected for analysis (2009 data)															
Fleet segment	**Capacity**			**Costs**							**Effort**			**Landin**		
	No. vessels	**Gross tonnage**	**kW**	**Crew**	**Fuel**	**Repair**	**other var. costs**	**Fixed costs**	**Total Costs**	**Employed FTE**	**Days at sea**	**GT days**	**KW days**	**Total (€)**	**Total cod (€)**	**T**
DEU_DTS1224	67	4,355	13,405	3,651,414	1,776,125	1,829,683	845,554	1,563,422	9,666,198	96	7,912	540,464	1,464,017	11,941,353	4,327,545	16,
DEU_DTS24XX	24	16,212	25,996	18,335,077	8,672,019	9,061,084	6,375,166	5,469,476	47,912,822	232	5,157	3,638,617	5,742,759	54,859,193	17,331,277	64,
DNK_DTS1218	177	5,875	32,074	8,362,094	4,361,993	4,867,604	4,420,029	3,585,689	25,597,409	269	22,010	738,327	3,920,672	35,551,681	8,595,083	52,
DNK_DTS1824	77	7,062	24,330	10,573,147	4,552,645	4,393,053	5,183,472	2,120,346	26,822,663	226	12,386	1,090,601	3,661,660	36,247,265	7,631,974	53,
DNK_PGP0010	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	38,168	145,761	1,605,413	13,676,268	3,542,971	6,
DNK_PGP1012	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	7,749	79,222	700,225	4,947,588	2,067,964	2,
DNK_PMP1012	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	2,750	32,863	279,318	1,953,069	931,958	1,
DNK_PMP1218	46	1,039	6,714	914,862	828,738	1,173,381	804,120	676,238	4,397,339	53	5,007	117,057	713,894	6,337,462	2,178,250	6,
DNK_TM2440	46	11,936	28,301	13,767,760	8,232,394	5,581,916	6,425,402	2,718,094	36,725,565	260	10,629	2,169,328	5,139,835	51,577,954	6,538,000	135,
LTU_DTS2440	22	2,579	4,855	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	1,278	100,715	189,118	2,279,150	2,110,169	2,
LVA_DFN2440	23	2,017	4,040	563,651	492,188	118,520	583,692	322,078	2,080,130	127	2,075	n.a.	n.a.	2,657,973	2,656,452	2,
POL_DFN1224	25	757	3,010	389,376	151,347	103,779	243,732	104,176	992,411	88	2,194	47	243	1,827,254	1,616,558	1,
POL_DTS1224	74	2,930	13,855	1,735,328	1,122,527	401,074	632,389	650,005	4,541,322	200	6,869	219,865	1,053,379	6,331,616	3,899,351	11,
POL_DTS2440	10	1,134	3,085	304,447	479,687	124,561	112,166	146,721	1,167,582	60	1,165	106,282	295,567	1,659,294	983,360	4,
POL_PG0012	556	2,529	21,842	2,236,240	850,175	501,828	914,365	672,478	5,175,086	425	43,937	4,947	56,709	9,621,314	3,787,636	11,
SWE_DTS1224	160	9,904	46,980	3,852,070	5,454,068	5,469,991	2,558,519	2,171,922	19,506,570	296	15,742	1,070,841	4,849,848	27,325,174	7,009,356	241,
SWE_DTS2440	31	6,493	20,187	1,468,049	4,345,742	2,493,244	1,178,983	2,049,433	11,535,451	86	3,798	789,649	2,532,344	13,876,095	3,550,573	93,
SWE_PG0012	809	3,776	53,799	571,603	2,125,070	2,921,828	1,243,092	1,835,238	8,696,831	384	63,965	317,383	4,500,370	12,830,576	3,735,678	67,

13. Cost Effectiveness of Control and Enforcement

The Members States were asked to describe the changes in control costs for Baltic Cod Management Plan (CMP) (2007-2010) during the period of implementation. The responding MS (5 of 8) provided their cost estimates for the period 2007-2010 (Figure 13.1).

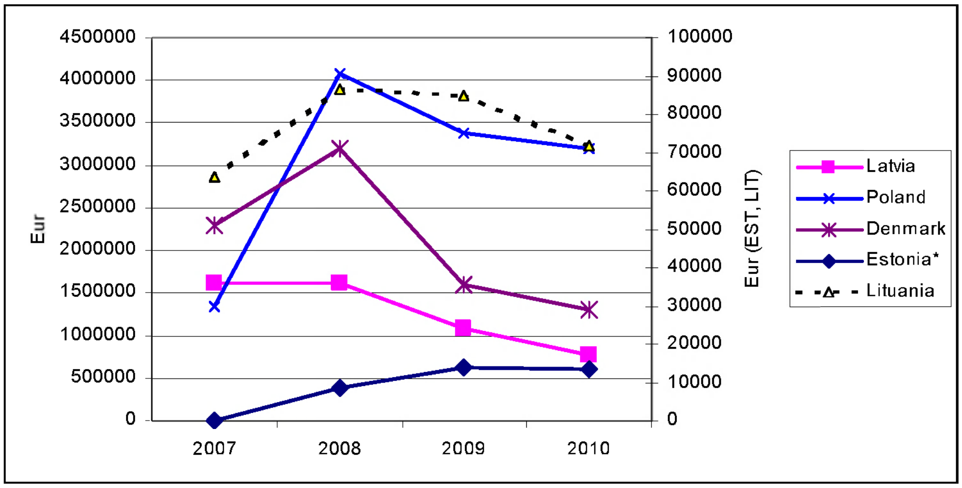


Figure 13.1. The control costs as presented by the Member States

However, the data provided to the EWG 11-07 indicates that the MS interpreted the data call differently and it is not clear if the basis for data is the same. So, Estonia describes its estimates as the costs inccured for exchange of inspectors and utilization of vessel patrol methods for the surveillance and inspection in the "main cod fishing areas" only, not in the overall fishing zone.

The control costs increased in Lithuania (by 36%), Poland (by 300%) and Denmark (by 40%) with by the CMP implementation year (2008) and decreased since then. Estonian costs reached maximum in 2009 and remained on the same level in 2010. Costs of Latvia have decreased by 50% since 2008.

14. Conclusions to the Impact Assessment

14.1. Outline of a future multiannual management plan for Baltic cod.

14.1.1. Objectives and targets:

The following considerations are based on the assumption that the objectives of a Baltic cod management plan are to ensure exploitation of the cod stocks that provides sustainable economic, environmental and social conditions and the aim is to restore and maintain the stocks at or above levels which can produce maximum sustainable yields not later than 2015.

The EWG considers that within the historical stock sizes exploitation of the two cod stocks at target fishing mortalities of 0.33 is consistent with the objective of MSY. If the stock sizes increase to a state where it influences the population parameters it may be necessary to adapt the target fishing mortalities to obtain MSY.

Discards are included in the F_{MSY} evaluations and a possible discard ban is unlikely to affect the conclusions unless a ban will result in a major change in the exploitation pattern.

A higher MSY could potentially be obtained for Eastern Baltic cod by changing size selection towards harvesting cod >70 to77cm.

14.1.2. Limitation of catches

The current enforcement of the TACs appears to be sufficient to control the total outtake. Discards have been relative limited and stable in recent years and the EWG concludes that the TACs have been effective in limiting fishing mortalities.

However, the past experiences show that it is important that a management plan includes options for actions to be taken in case the TACs are shown to be ineffective in limiting fishing mortalities.

F target based harvest control rules with catch calculated using a short term forecast and a percentage constraint on inter-annual change in TAC are considered appropriate in defining the TACs for both stocks. However, the simulations presented in section 7 indicate that a 15% constraint on inter-annual variation in the TACs is not required to achieve the biological objectives.

Although discards appear at present not to be a problem in relation to limiting fishing mortality, a management plan should include explicit rules for addressing discards. This could be implemented by defining the TAC as total allowable catch and by ensuring that all catches (landings as well as discards) are counted against the TAC.

Recreational catches constitute, in certain areas, a measurable and variable part of the total catches and to ensure a proper limitation of total catches, catches of cod in the recreational fisheries should be addressed in the management plan.

14.1.3. Limitation of fishing effort

The evaluation of the present multiannual management plan and the simulations presented in section 7 indicate that rules for effort limitations are not required to meet the biological objectives as long as the limitations in catches is effective in limiting the fishing mortality as intended.

However, it might be useful to include options in a management plan allowing for limitations of the fishing effort in case the TACs prove not to be effective in limiting the fishing mortalities as intended.

14.1.4. Spawning closures

The impact on the present spawning closures on the stocks and the fisheries is unclear but the measures are unlikely to have had a limiting effect on the overall fishing mortality and EWG concludes that spawning closures are not required to meet the biological objectives as long as the TACs effective in limiting the fishing mortalities as intended.

If spawning closures are included in a future management plan it is recommended that it is ensured that the timing of the closures match the spawning periods of the spawning components to be protected.

14.1.5. Other measures (gear rules, MLS, etc)

A number of technical measures including gear rules, minimum landing size and maximum by-catch percentages currently included in the technical measures regulation affect the fisheries on the cod stocks. These measures have little impact on the overall fishing mortality and are not required to meet the biological objectives as long as the limitations in catches is effective in limiting the fishing mortality as intended.

The measures may, however, have had a positive impact on the exploitation pattern on cod and as such a positive impact on the yield per recruit.

14.2. Forward look to Evaluation

STECF considers 5 years a minimum time for data to be available for review

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Annex 1 Review of single species MSY points for Baltic cod stocks

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Summary

The purpose of the study is to evaluate target and ranges of constant F exploitation for both Baltic cod stocks, based on available assessment data. Recruitment is modelled though stochastic multiple model based simulation for 1000 constructed "populations" for each stock by randomly sampling with replacement selection at age in the fishery, maturity and weights at age in the catch and weights at age in the stock for the selected periods. S-R models were fitted in a Bayesian framework, three models S-R models were applied, Hockey-stick (HS), Ricker (RK) and Beverton-Holt (BH). More complex models with more parameters are not tested but are thought to fit more poorly. Three time periods for S-R are examined for each cod stock. The probability of each model type is selected for the set using the statistical method proposed by Kass and Rafferty (1995) applied as described in detail for S-R functions in Simmonds et al (2011) where it was used for the ICES MSE for mackerel. Differences between slope to the origin are not significant among dataset and stocks. Modeling is repeated using a single model specific slope factor for each model type, (BH, HS and Rk).

Variability in growth maturation and selection in the fishery is obtained by drawing historically observed values at random from the assessment data sets, to account for differences over time different groupings are selected for comparison. Comparison is made between estimated Fmsy target values and the range over which yield are maintained within 95% of yield at Fmsy. The results include observed variation and are based on single stock exploitation.

In order to test for the possibility of simplifying the modeling for use in evaluations the estimates of Fmsy and >95% interval were repeated using fixed or variable coefficient HS models only. Ignoring the uncertainty in S-R modeling gave slightly different target values for both stocks and for Eastern cod indicated greater stability in catch over F than is suggested if modeling uncertainty is included.

Introduction

There has been some uncertainty in the functional form and parameters for S-R functions for both Baltic cod populations. Choice of a single functional form and one set of parameters can influence the implied stock dynamics, but the choice can only be made with considerable uncertainty. The approach here allows several functional forms to be tested simultaneously with the parameters and proportions of each form to be based on the data. This approach does not give the definitive function rather it allows exploration of exploitation recognizing the uncertainty and giving the possibility of selecting targets in the presence of this uncertainty.

Methods

Data

Data is taken from ICES 2011 assessments of the Baltic cod stocks (ICES 2011) using SSB/R pairs from years available. As the Baltic has seen different regimes in the past models are fitted to three different periods to examine the consequences of selecting different sets of data.

Eastern Baltic cod (SD 25-32):

Year ranges for R and SSB defined by yearclasses

- Entire assessment time series (year classes 1966-2007)
- 1988-2007 (after the regime shift, starting year in line with long term simulations of MP; Bastardie et al. 2010)
- Recent 1994 to 2007 (if necessary by rescaling mean) based on ecosystem study showing transition to recent regime finishes in 1993

Year ranges to parameterize weight and maturity at age and maturity

- 1981-2010 (for earlier years constant values are used in assessment)
- 2005-2010 (as weight as continuously declined in recent decade)

Year ranges to parameterize selection (exploitation pattern in the fishery)

- 2007-2010
- 2004-2010

Weights at age in the catch mean and range by group specified above Figure 1

Weights at age in the stock mean and range by group specified above Figure 1

Maturity at age in the stock mean and range by group specified above Figure 2

Selection at age in the fishery mean and range by group specified above Figure 2

Western Baltic cod (SD 22-24):

Year ranges for R and SSB defined by yearclasses

- 1. Entire assessment time series (year classes 1970-2009)
- 2. 1986-2009 (low recruitment period, starting year in line with long-term simulations of MP; Bastardie et al. 2010)
- 3. Recent 1994 to 2009 (if necessary by rescaling mean) based on ecosystem study showing transition to recent regime finishes in 1993

Year ranges to parameterize weight and maturity at age

- 1. 1982-2010 (for earlier years constant values are used in assessment)
- 2. 2008-2010 (due to recent drastic decline)

Year ranges for parameterising selection (exploitation pattern in the fishery)

- 2008-2010

Weights at age in the catch mean and range by group specified above Figure 1

Weights at age in the stock mean and range by group specified above Figure 1

Maturity at age in the stock mean and range by group specified above Figure 2

Selection at age in the fishery mean and range by group specified above Figure 2

Note that maturity and weight are drawn as year sets, hence year ranges are maintained equal (which is close to but not fully in compliance with scoping document ICES 2011b)

The uncertainty in modeling is limited to match variability used in the assessment.

Populations are parameterized as 1000 separate populations that includes:-

The random draws selects a year and draws all parameters from that year so correlation between weights etc. observed is maintained in the simulations, however, cohort effects are ignored. The following parameters are not varying in the assessment and the simulations do not include variability in the following:-

Annual variability in time of spawning

Annual variability in timing of fishery

Annual variability in natural mortality

Recruitment simulation

Preliminary investigation of modeling suggested that fitting individual stock models implied different stock dynamics (Table 2) slope at the origin for HS models vary from 1.32, to 4.45. The range is influenced greatly by the observed exploitation rates which differ among stocks limiting the range of observed biomass. In order to account for this a combined modeling approach was also investigated.

Recruitment is modelled though stochastic multiple population model based simulation for the populations. Models are fitted in a Baysian framework. The underlying assumption is that cod has generic exploitation form which can be scaled to the carrying capacity for each stock, but the resilience, the slope (R/SSB) to the origin is estimarted independently or consistently across stocks. Each stock retains its own estimated growth and maturation.

Three models are used are used

Hockey-stick model $R = \exp(A_h * B_{sh} * SSB + RND(\sigma))$ $(SSB>B)$

$\exp(A_h * SSB + RND(\sigma))$ $(SSB<B)$

Ricker model $R = \exp(A_r * SSB * \exp(-1/B_{sr} * SSB))$

Beverton Holt model $R = \exp(SSB/(A_b + B_{sb} * SSB))$

Where the A parameter which defines the slope to the origin, A and B are first independent for each model, stock and data period. Under these assumptions the HS models evaluate the difference in slope to the origin. These independent fits to each data set do not support significant difference among periods and stocks. So for a second modeling run the A parameters were taken as common among stocks and periods. The effect of this is that a common 'shape' of stock response is independently scaled to each period and stock, and the shape is selected based on all the data combined. This approach is used because the uncertainty in shape for the heavily truncated data sets has a strong influence on the results (see below). This necessity to just 'rescale' S-R functions for truncated series was recognized in the scoping meeting (ICES 2011b)

The probability of each model type is selected for the set using the method described in Simmonds et al (2011).

The combinations of the year ranges used to parameterize the options tested are summarized in Table 1

Population Simulation

The methods used conform to the methods described in ICES 2010b and matches the population dynamics fitted in the assessment. Simulation of exploitation is carried out at a range of constant F exploitation with selection at age as described above. The populations are taken to equilibrium by exploitation for 100 years and run a further 50 years to obtain equilibrium values for distribution of recruitment, SSB, catch and landings. The software has been validated by comparison between simulations of plaice carried out in IMARES for the STECF expert group SGMOS 10-06 (STECF 2010)

Estimation of Fmsy

Two criteria are used to estimate F_{msy}:

a) using the distribution of estimates of F_{msy} by population to give a probability of F_{msy} from which the median value is assumed to be the most unbiased point estimate. (50% probability of Fmsy is too high and 50% too low)

b) The maximum in the relationship between mean landings over F, this defines an integrated measure taking account of the sensitivity of mean yield with mean F the point value for F_{msy} is the F value giving the maximum mean landings. (this effectively weights the importance of results at F by the landings at that F, giving a point that has the likelihood of giving the highest yield)

Estimation of Blim (and Bpa)

In addition to MSY values in order to be informative with respect to the precautionary approach, following the methodology in the ICES PA framework of 2003 (ICES 2003) the median of the distribution of the breakpoints for the HS model fitted (in this case fitted the Bayesian framework) is used to give estimates of B_{lim} by period and stock. B_{pa} is not required for this analysis but for comparison with previously estimated values of B_{pa} are derived as B_{lim}*1.4.

As no estimates of Bpa or Blim are available for Eastern Baltic cod the estimated values are used. In this case for further analysis Bpa for Western cod is available from ICES advice. To obtain a comparable Blim, it is estimated as Blim=Bpa/1.4. These values do not influence Fmsy estimation, but are included for to indicate if precautionary aspects are likely or not to be in conflict with MSY estimates.

Inclusion of errors

In the exploitation target F will not be implemented accurately, due to noise in the data, retrospective bias in the assessment, implementation errors in the exploitation or agreed inter-annual limits to the change in TAC. All these contribute to a distribution of realized F around a target F. If there are know biases these can be removed as simple shift in target. Once biases are removed the error can be considered as a distribution and to set the impact of this the results are convolved with an error distribution in F. Currently this has not been done with this study. As estimates of Fmsy (see below) tend to be well away from Fs associated with precautionary aspects the impact of uncertainty is expected to smooth the responses slightly but otherwise have a minor impact.

Results

S-R modelling

For independently estimated model parameter estimates and examples of simulated recruitment are illustrated in Figure 3-8 for Eastern Baltic cod and Figure 9-14 for Western Baltic cod. The joint posterior distributions of parameters A and B for each model are shown in the first figure for each stock. The model fits shown in the second figure are compared with the observations in two ways,

- as 50 randomly selected models from the 1000 available from the MCMC and
- as quantiles of R against SSB (0.05,0.25,0.50,0.75 and 0.95).

Also on these plots for comparison the maximum log likelihood model is also shown as a single black line.

Estimated parameter values for each type of model and 95% intervals on the distributions are given in Table 2

Following the method of Simmonds et al 2011, the proportion of models (HS, RK and BH) for the set models for each of the stocks and the sets of S-R pairs is evaluated and the results are given in Table 3.

Simulated S-R data is shown in Figures 3-14 (even number Figures)

This process provides a basis for simulating recruitment that includes the uncertainty in S-R functional form and the parameters of the model but is conditional on the range of models tested. Evaluation of more complex models does not give significantly different model forms, but all fit more poorly due to addition of parameters. For this reason other more complex (4 parameter) models are not evaluated here.

For Eastern Baltic cod model fits to the most truncated data set (14 year classes1994 to 2007) have a much better fit to Ricker than other models due to the low values of recruitment at higher biomass, particularly the 1995 value. To achieve a fit with this truncated data this model fit with an A parameter (the slope) increased implying that the smaller stock with lower recruitment is more resilient, this increase of resilience seems unlikely, and is thought to be the result to the one or two lower values at higher biomass, rather than a real phenomena. Comparing the A parameter on the HS for Eastern and Western cod (including a correction for the Eastern stock for M =0.8 used for the assessment of the Western stock) suggests no significant difference in slope to the origin (Figure 15) implying the resilience (F crash) would be expected to be similar. While the stock dynamics appears to be dependent on the carrying capacity which is varying with between stocks and for the Eastern stock significantly with time (Table 2). There is not much evidence of decline in recruitment at high biomass for the longer timeserise to support strong recruitment dependence at high biomass.

To provide a more stable modeling approach taking account of the inability to determine differences among slopes to the origin, a stronger hypothesis is tested. Given that differences in slope cannot be detected, a common slope parameter is fitted. This approach assumes that one A parameter estimated with error is more informative than 6 independent values that are not found to be statistically significantly different. Carrying capacity expressed as B coefficients in the models are independent across stocks and data periods.

For the combined A coefficients and independent B model parameter estimates are given in Table 4 and examples of simulate recruitment are illustrated in Figure 16-21 for Eastern Baltic cod and Figure 22-27 for Western Baltic cod.

Estimated parameter values for each type of model and the 95% intervals are given in Table 4

Following the method of Simmonds et al 2011, the proportion of models (HS, RK and BH) for the set models for each of the stocks and the sets of S-R pairs is evaluated and the results are given in Table 5. As the coefficients across stocks and periods are now dependent a proportions are defined for each stock rather than each data period.

PA Reference point estimation

As Blim values are not available for these two stocks, these were estimated for based on the B values of the HS S-R fits. The distribution of the parameters and the median estimates are shown in Figures 3-14 (odd numbers). However, only for the Eastern stock are estimated values of Blim (Table 6) used directly. For Western Baltic cod the values in Table 6 are not the fitted values but those based on the Bpa in the advice sheets from ICES. For comparison between stocks and ICES B_{pa} values it is assumed that Bpa =1.4 * B_{lim} (these values are also given in Table 6).

Equilibrium exploitation modelling

Selected results of equilibrium exploitation by stock are given in Figures 28-33 for varying resilience across stocks and periods and Figures 34-39 for common resilience S-R functions. For Eastern Baltic cod the range of F associated with MSY is close to the historic range of SSB. For Western Baltic cod this is not the case. As the stock has been exploited only at relatively high F exploitation at lower F is has not been observed, so values below F 0.6 imply an exploitation well below the observed range and a higher SSB than those previously observed.

The distribution of Fmsy and maximum landings from all sets given in the Table 1 are shown in Figure 40a with the point estimates of Fmsy summarised in Table 6. Assuming resilience varying across stocks and periods the plots in Figure 40 show the distribution of estimates of F_{msy} based on the exploitation of the 1000 populations (Figure 40a) and the mean landings over all populations against F (Figure 40b). For the assumption of consistent resilience across stocks and periods the distribution of Fmsy and maximum landings from all sets given in the Table 1 are shown in Figure 41 with the point estimate Fmsy values in Table 7. The mean landings results also allow an estimate of the sensitivity of mean landings to the choice of F.

Variation in SSB and yield are summarised for all options in Figures 42-46 for both stocks. The distribution SSB from maximum yield, and for the F that would give 95% of maximum yield are estimated to the nearest 0.05. All these results are summarized in Figure 47.

Discussion

Not unexpectedly the S-R modeling is uncertain, the relationships have a wide range of parameter values and the proportions of models depend on the choice of period. Nevertheless, most of the distributions give very similar dynamics. Given the overall uncertainties Western Baltic shows only minor dependence on choice of data. The same is true for Eastern cod except when S-R data is reduced to data just from 1994-2007. In this case the Ricker model fits much better to this data due almost entirely to the 1995 yearclass, when very low recruitment occurred at high biomass. There are no other high biomass values during this period. Similar biomass is currently observed (2009,2010) but estimates of recruitment are not yet available. The consequence of the Ricker for to this truncated series is that the stock resilience apparently improves with a regime that gives declining recruitment and stock size. This is counter intuitive and may be an artifact of fitting to such limited data.

Single stock exploitation values for Western Baltic cod are fairly consistent over choice of S-R data periods (Table 3). The same is true for Eastern cod unless data is cut down to less than half the values with a starting year of 1994. For the Eastern stock both mean landings and median Fmsy are fairly consistent with one another and with 0.3 (assuming the 1994-2009 data is too short to be informative). For the Western stock the two estimation methods do not give the same results (Table 3). The median expresses a value which is selected because 50% are greater, 50% lower, for the Western stock this value is slightly higher than the value for the Eastern stock(Table 3) . The maximum mean landings take into account yield which would generally be a more applicable choice of value, but the lower Fs imply extrapolation further away from the historic observations we have (that are all at high F), in this case the values for the Western stock are lower than those for the Eastern stock.

Most of these aspects are reduced when taking the hypothesis that resilience is not dependent on stock or period. This approach still includes uncertainty in all the parameter estimates and brings this through into the conclusions.

Using these more stable values estimated >95% single stock exploitation ranges for Eastern and Western Baltic cod are 0.2-0.55 and 0.2 to 0.5 respectively and both stocks giving maximum landings at F=0.3 (±0.025) and a median Fmsy of 0.33. It should be noted that although the values are similar basis is slightly different and is based on different age ranges. (Eastern 4-7 and Western 3-6).

Overall the range of estimated values is not heavily dependent on choice of period for recruitment, selection or growth.

Values around 0.3 for Eastern Baltic cod do not imply exploitation substantively away from observed biomass, however for Western Baltic cod the data available to not cover the range of F=Fmsy. Published evaluations of recruitment (Mantzouni, et al 2010, Mantzouni and Mackenzie 2010) indicate similarity between paramaterisation of the two Baltic stocks. The results here also suggest exploitation that is not so different across populations.

Use of simplified S-R functions

To test if HS functions can provide adequately similar dynamics the equilibrium models were run with all 1000 models allocated to HS models (with variable parameters), and secondly with HS with a single parameter set based on geometric mean (A*B) with a break point at mean (B). The use of fixed parameters results in a small reduction in mean recruitment (of about 4%) over the use of the variable parameter set, this is thought to be due to higher sigma associated with a small number of models with high A*B. The results in terms of F for maximum landings, medium Fmsy and limits of F for landings >95% are compared in Figure 47. For Eastern Baltic cod the HS models tend to give higher F targets and higher wider intervals. The wider intervals would give an impression of greater stability in yield at higher Fs that are probably not certain. For Western Baltic cod the HS models give slightly lower targets and intervals. In both cases there is greater sensitivity in target to choice of period for growth and selection, suggesting the uncertainty in recruitment modeling smears, or smoothes the small range of selection and growth variability used in the bootstrap. Provided Fs are maintained between 0.20 and 0.45 the difference in dynamics are probably negligible. However, particularly for Eastern Baltic cod risks of depletion may be underestimated for Fs > 0.5. The issue is less important for Western Baltic which does not exhibit the same increase in catch stability at higher F when modeled with HS S-R functions.

Conclusions

Based on single stock analysis there is insufficient data to detect differences in S-R resilience (slope to the origin) across stocks or between periods. Differences in carrying capacity are different across stocks and periods, particularly for Eastern Baltic cod. Using the available data to obtain the best point estimates of Fmsy for single species exploitation suggest that the choice of values is not heavily dependent on growth, selection or recruitment period (assuming consistent resilience). High yields can be obtained between F=0.2 to 0.5 and that maximum yields for a fixed F exploitation are estimated to be a little above 0.30, maybe up to 0.33, for both stocks (Eastern F averaged over ages 4-7 and Western F averaged over ages 3-6).

If the primary objective is to understand variability, and not to select target values it is probably acceptable to evaluate these stocks with fixed parameter HS. Provided that it is anticipated that F for Eastern cod remains within 0.2 to 0.45 which should be acceptable given the current F.

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Table 1 The set of simulation conditions for both stocks

Set number	SR – function	Selection	Weights	Maturities
EB 1	1966-2007	2004-2010	1981-2010	1981-2010
EB 2	1966-2007	2007-2010	1981-2010	1981-2010
EB 3	1966-2007	2004-2010	2007-2010	2007-2010
EB 4	1966-2007	2007-2010	2007-2010	2007-2010
EB 5	1988-2007	2004-2010	1981-2010	1981-2010
EB 6	1988-2007	2007-2010	1981-2010	1981-2010
EB 7	1988-2007	2004-2010	2007-2010	2007-2010
EB 8	1988-2007	2007-2010	2007-2010	2007-2010
EB 9	1994-2007	2004-2010	1981-2010	1981-2010
EB 10	1994-2007	2007-2010	1981-2010	1981-2010
EB 11	1994-2007	2004-2010	2007-2010	2007-2010
EB 12	1994-2007	2007-2010	2007-2010	2007-2010
WB 1	1970-2009	2008-2010	1981-2010	1981-2010
WB 2	1970-2009	2008-2010	2008-2010	2008-2010
WB 3	1986-2009	2008-2010	1981-2010	1981-2010
WB 4	1986-2009	2008-2010	2008-2010	2008-2010
WB 5	1994-2009	2008-2010	1981-2010	1981-2010
WB 6	1994-2009	2008-2010	2008-2010	2008-2010

Table 2 S-R model parameter estimates for different S-R pairs.

Stock	S-R	Param	Model	mean	CV	2.50%	median	97.50%
EB	Full	B	BH	0.001967	5.66E-04	9.29E-04	0.001942	0.003152
EB	Mid	B	BH	0.006984	6.15E-04	0.005614	0.007031	0.008084
EB	Rec	B	BH	0.006539	8.41E-04	0.004601	0.006633	0.007948
EB	Full	A	BH	0.4834	0.1224	0.251	0.4799	0.733
EB	Mid	A	BH	0.05437	0.05242	0.001549	0.03857	0.1936
EB	Rec	A	BH	0.07497	0.07317	0.002103	0.05325	0.2659
EB	Full	B	HS	299.6	105.5	140.1	295.2	527.3
EB	Mid	B	HS	63.45	9.77	50.54	61.77	85.93
EB	Rec	B	HS	65.03	14.29	50.55	62.82	91.62
EB	Full	A	HS	1.342	0.2796	1.013	1.281	1.927
EB	Mid	A	HS	2.197	0.3264	1.588	2.198	2.792
EB	Rec	A	HS	2.242	0.365	1.58	2.232	2.935
EB	Full	B	RK	629	157.8	405.5	601.6	1016
EB	Mid	B	RK	126.8	15.01	103.1	124.8	161.6
EB	Rec	B	RK	107.6	19.09	83.53	104.2	151.4
EB	Full	A	RK	1.694	0.2215	1.314	1.675	2.189
EB	Mid	A	RK	3.284	0.4362	2.492	3.264	4.21
EB	Rec	A	RK	3.942	0.6451	2.713	3.924	5.286
EB	Full	σ	BH	0.5166	0.05953	0.4165	0.5112	0.6489
EB	Mid	σ	BH	0.2674	0.04811	0.1928	0.2608	0.3794
EB	Rec	σ	BH	0.2781	0.06382	0.1858	0.2677	0.4318
EB	Full	σ	HS	0.5562	0.06363	0.4484	0.5503	0.6975
EB	Mid	σ	HS	0.2577	0.04521	0.1872	0.2519	0.3628
EB	Rec	σ	HS	0.2654	0.05979	0.1791	0.2554	0.4079
EB	Full	σ	RK	0.523	0.05978	0.4227	0.5172	0.6573
EB	Mid	σ	RK	0.2497	0.04441	0.1807	0.2439	0.3531
EB	Rec	σ	RK	0.2261	0.05322	0.1504	0.2171	0.3568

WB	Full	B	BH	0.00518	0.003538	2.50E-04	0.004632	0.0133
WB	Mid	B	BH	0.01613	0.005758	0.003107	0.01684	0.02603
WB	Rec	B	BH	0.009578	0.006481	4.09E-04	0.008748	0.02313
WB	Full	A	BH	0.3088	0.1105	0.07551	0.3174	0.4978
WB	Mid	A	BH	0.1492	0.1263	0.004535	0.114	0.4678
WB	Rec	A	BH	0.323	0.1772	0.02188	0.3243	0.6594
WB	Full	B	HS	41.67	8.653	12.71	43.23	51.54
WB	Mid	B	HS	15.78	8.985	9.617	12.49	46.18
WB	Rec	B	HS	31.09	13.34	10.14	32.6	51.08
WB	Full	A	HS	2.455	0.7584	1.834	2.294	5.271
WB	Mid	A	HS	3.757	1.048	1.82	3.807	5.77
WB	Rec	A	HS	2.566	1.093	1.427	2.171	5.504
WB	Full	B	RK	85.96	23.66	47.43	83.29	139.4
WB	Mid	B	RK	69.91	24.4	30.91	66.98	124.9
WB	Rec	B	RK	79.56	25.13	38.37	76.83	136.1
WB	Full	A	RK	3.36	0.5559	2.509	3.281	4.656
WB	Mid	A	RK	3.115	0.7556	2.054	2.992	4.936
WB	Rec	A	RK	2.888	0.713	1.888	2.776	4.529
WB	Full	σ	BH	0.6757	0.07933	0.5418	0.6684	0.8522
WB	Mid	σ	BH	0.6916	0.1123	0.5132	0.6774	0.9481
WB	Rec	σ	BH	0.6985	0.1398	0.4882	0.6771	1.027
WB	Full	σ	HS	0.6791	0.081	0.5432	0.6714	0.8573
WB	Mid	σ	HS	0.6959	0.1149	0.5136	0.6823	0.9609
WB	Rec	σ	HS	0.7026	0.1394	0.4922	0.6818	1.035
WB	Full	σ	RK	0.6773	0.0794	0.5442	0.6697	0.8527
WB	Mid	σ	RK	0.7291	0.1163	0.5438	0.7152	0.997
WB	Rec	σ	RK	0.6955	0.1379	0.4893	0.6745	1.022

Table 3 Proportion of models by type, for three periods of S-R data

Stock	S-R period	HS	RK	BH
Eastern	Full	0.027	0.436	0.537
	Mid	0.692	0.003	0.305
	Recent	0.256	0.672	0.072
Western	Full	0.211	0.394	0.395
	Mid	0.307	0.217	0.476
	Recent	0.311	0.374	0.315

Table 4 S-R model parameter estimates for different S-R pairs.

Stock	S-R	Param	Model	mean	CV	2.50%	median	97.50%
EB	Full	B	BH	0.001623	2.76E-04	0.001086	0.001624	0.002164
EB	Mid	B	BH	0.002855	3.58E-04	0.002095	0.002879	0.00349
EB	Rec	B	BH	0.002701	4.17E-04	0.00181	0.00273	0.003447
EB	Full	A*	BH	0.0272	0.0166	0.0019	0.0254	0.0646
EB	Full	B	HS	165.7	35.27	116	161.3	250.1
EB	Mid	B	HS	75.34	8.473	60.49	74.9	94.07
EB	Rec	B	HS	78.35	14.12	61.47	77.04	102.1
EB	Full	A*	HS	1.80	0.18	1.47	1.79	2.17
EB	Full	B	RK	600.3	124.2	412.5	581.6	896.4
EB	Mid	B	RK	257.3	65.36	174.4	244.1	417.6
EB	Rec	B	RK	342.5	149.7	178.9	304	741.9
EB	Full	A*	RK	1.73	0.17	1.44	1.71	2.13
EB	Full	σ	BH	0.5735	0.07065	0.4528	0.5671	0.728
EB	Mid	σ	BH	0.2904	5.61E-02	0.2034	0.2829	0.4202
EB	Rec	σ	BH	0.296	0.0695	0.1947	0.2846	0.4631
EB	Full	σ	HS	0.5655	0.06539	0.4548	0.5595	0.7102
EB	Mid	σ	HS	0.2663	0.04743	0.1927	0.2601	0.3769
EB	Rec	σ	HS	0.2796	0.06441	0.1872	0.2689	0.4325
EB	Full	σ	RK	0.5217	0.05909	0.4216	0.5163	0.6519
EB	Mid	σ	RK	0.3946	0.07711	0.2707	0.3856	0.5714
EB	Rec	σ	RK	0.4307	0.09816	0.2815	0.4164	0.6637
WB	Full	B	BH	0.01328	0.002225	0.008992	0.01326	0.01773
WB	Mid	B	BH	0.01957	3.57E-03	0.01293	0.0194	0.02708
WB	Rec	B	BH	0.01869	0.004111	0.01148	0.01838	0.02777
WB	Full	A	BH	0.06064	0.037	0.0043	0.05642	0.1438
WB	Full	B	HS	17.74	4.812	12.38	16.87	33.11
WB	Mid	B	HS	12.15	2.096	9.658	11.76	16.75
WB	Rec	B	HS	13.82	4.023	9.81	13.1	21.37
WB	Full	A	HS	4.013	0.3914	3.267	3.993	4.832
WB	Full	B	RK	70.78	16.93	45.05	68.31	110.6
WB	Mid	B	RK	52.39	16.53	29.79	49.18	93.13
WB	Rec	B	RK	59.73	19.07	32.77	56.2	106.4
WB	Full	A	RK	3.855	0.387	3.21	3.812	4.73
WB	Full	σ	BH	0.7069	0.08339	0.567	0.6988	0.8927
WB	Mid	σ	BH	0.6765	0.108	0.5046	0.6633	0.9236
WB	Rec	σ	BH	0.7092	0.1404	0.4966	0.6882	1.043
WB	Full	σ	HS	0.7334	0.08655	0.5882	0.7253	0.9291
WB	Mid	σ	HS	0.6752	0.1079	0.5053	0.6616	0.9265
WB	Rec	σ	HS	0.7158	0.143	0.5009	0.6945	1.056
WB	Full	σ	RK	0.6845	0.08072	0.5488	0.6767	0.8651
WB	Mid	σ	RK	0.7325	0.12	0.5423	0.717	1.011
WB	Rec	σ	RK	0.7282	0.1459	0.507	0.7065	1.07

* estimated with A parameters for WB and reduced to account for natural mortality M=0.8

Table 5 Proportion of models by type, for three periods of S-R data

Stock	HS	RK	BH
Eastern	0.463	0.000	0.536
Western	0.098	0.108	0.793

Table 6 Results of estimated Fmsy values for three different S-R data periods, and combinations of selection weight and maturity periods (see Table 1). MSY based on median of population distribution of Fmsy and Max of mean landings (to nearest 0.05). Assuming recruitment resilience (A parameter on S-R function) is different across stocks and data periods.

Stock	S-R	Sel, Wts	Blim	Bpa	MSY:median	Maxmeanland
East	1	1	298	417	0.37	0.35
East	2	1	62	87	0.34	0.35
East	3	1	63	88	0.86	0.80
East	1	2	298	417	0.36	0.30
East	2	2	62	87	0.42	0.40
East	3	2	63	88	0.78	0.75
East	1	3	298	417	0.35	0.30
East	2	3	62	87	0.30	0.30
East	3	3	63	88	0.89	0.85
East	1	4	298	417	0.34	0.30
East	2	4	62	87	0.34	0.30
East	3	4	63	88	0.83	0.80
West	1	1	16	23	0.33	0.25
West	2	1	16	23	0.33	0.25
West	3	1	16	23	0.40	0.30
West	1	2	16	23	0.34	0.25
West	2	2	16	23	0.35	0.30
West	3	2	16	23	0.41	0.25

Table 7 Results of estimated Fmsy values for three different S-R data periods, and combinations of selection weight and maturity periods(see Table 1). MSY based on median of population distribution of Fmsy and Max of mean landings (to nearest 0.05). Assuming recruitment resilience (A parameter on S-R function) is common across stocks and data periods.

Stock	S-R	Sel, Wts	Blim	Bpa	MSY:median	Maxmeanland
East	1	1	161	225	0.33	0.35
East	2	1	75	105	0.33	0.30
East	3	1	77	108	0.32	0.30
East	1	2	161	225	0.39	0.35
East	2	2	75	105	0.38	0.35
East	3	2	77	108	0.37	0.35
East	1	3	161	225	0.29	0.30
East	2	3	75	105	0.28	0.30
East	3	3	77	108	0.29	0.30
East	1	4	161	225	0.35	0.30
East	2	4	75	105	0.33	0.30
East	3	4	77	108	0.33	0.30
West	1	1	16	23	0.31	0.30
West	2	1	16	23	0.31	0.25
West	3	1	16	23	0.31	0.30
West	1	2	16	23	0.35	0.35
West	2	2	16	23	0.33	0.30
West	3	2	16	23	0.33	0.30

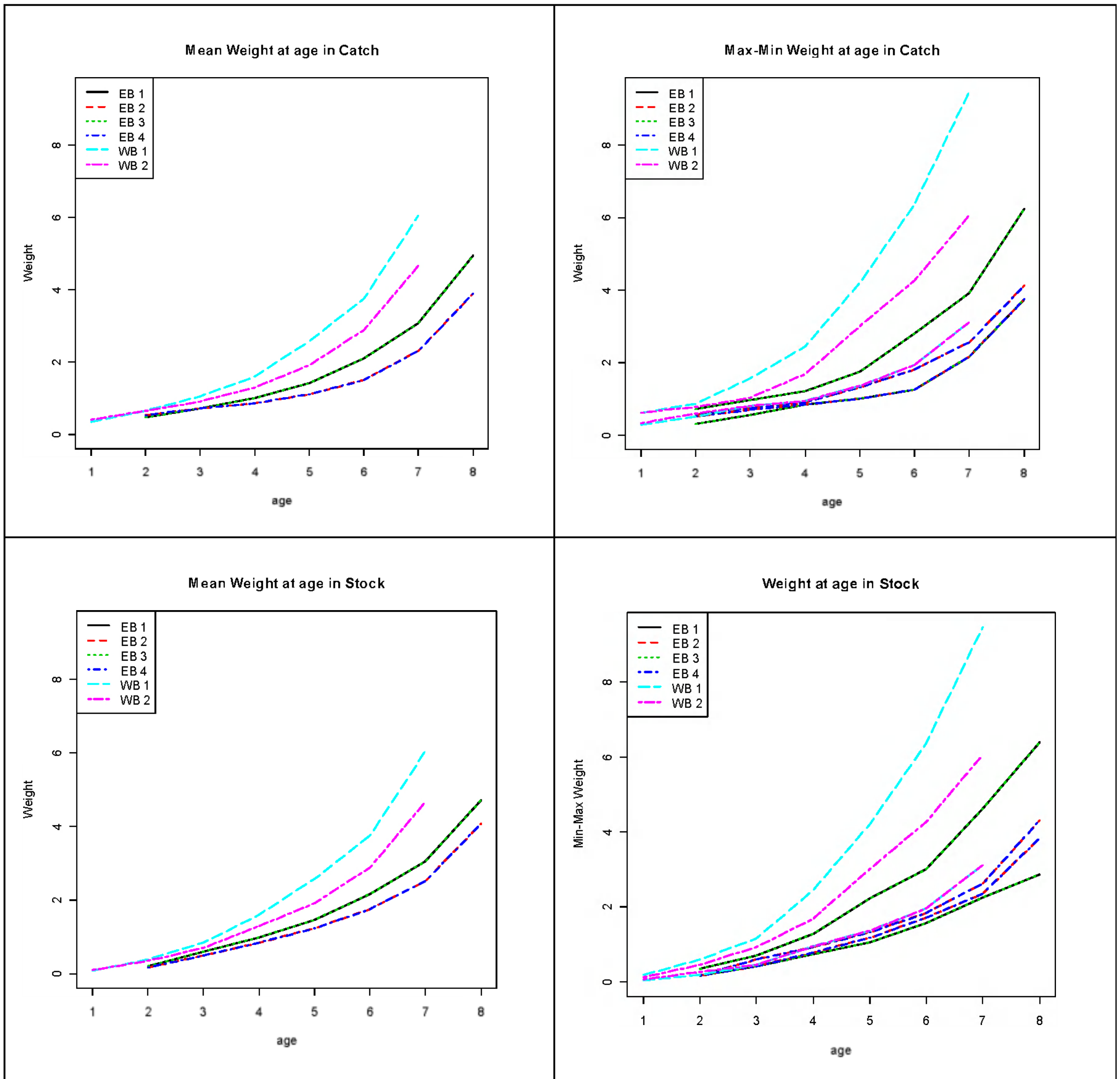

Figure 1Mean weights at age in stock and catch by stock, and by grouping: mean of group and range of the group (min-max)

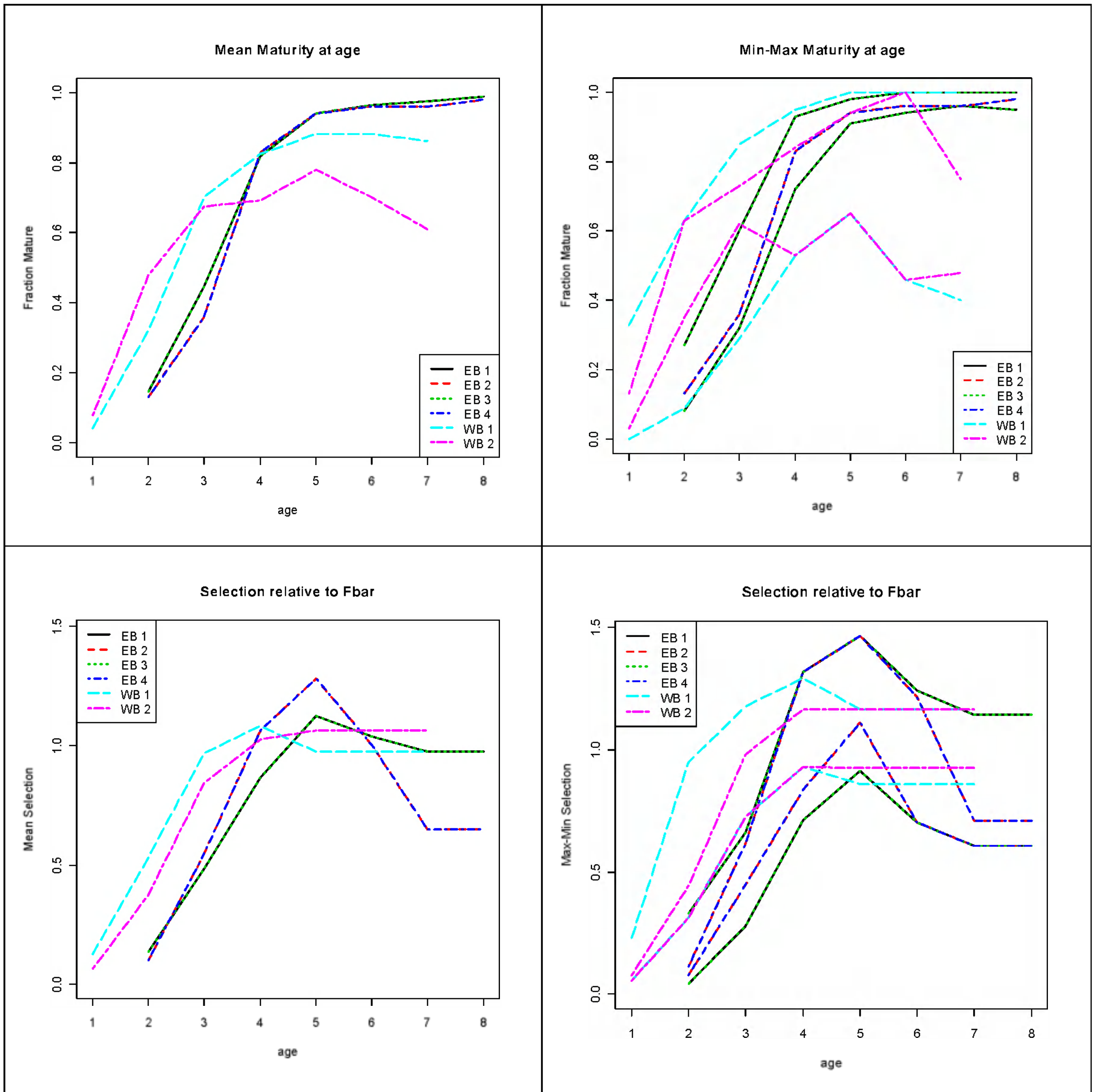

Figure 2. Maturity and selection at age by stock, and by grouping: mean of the group and range of the group (min-max)

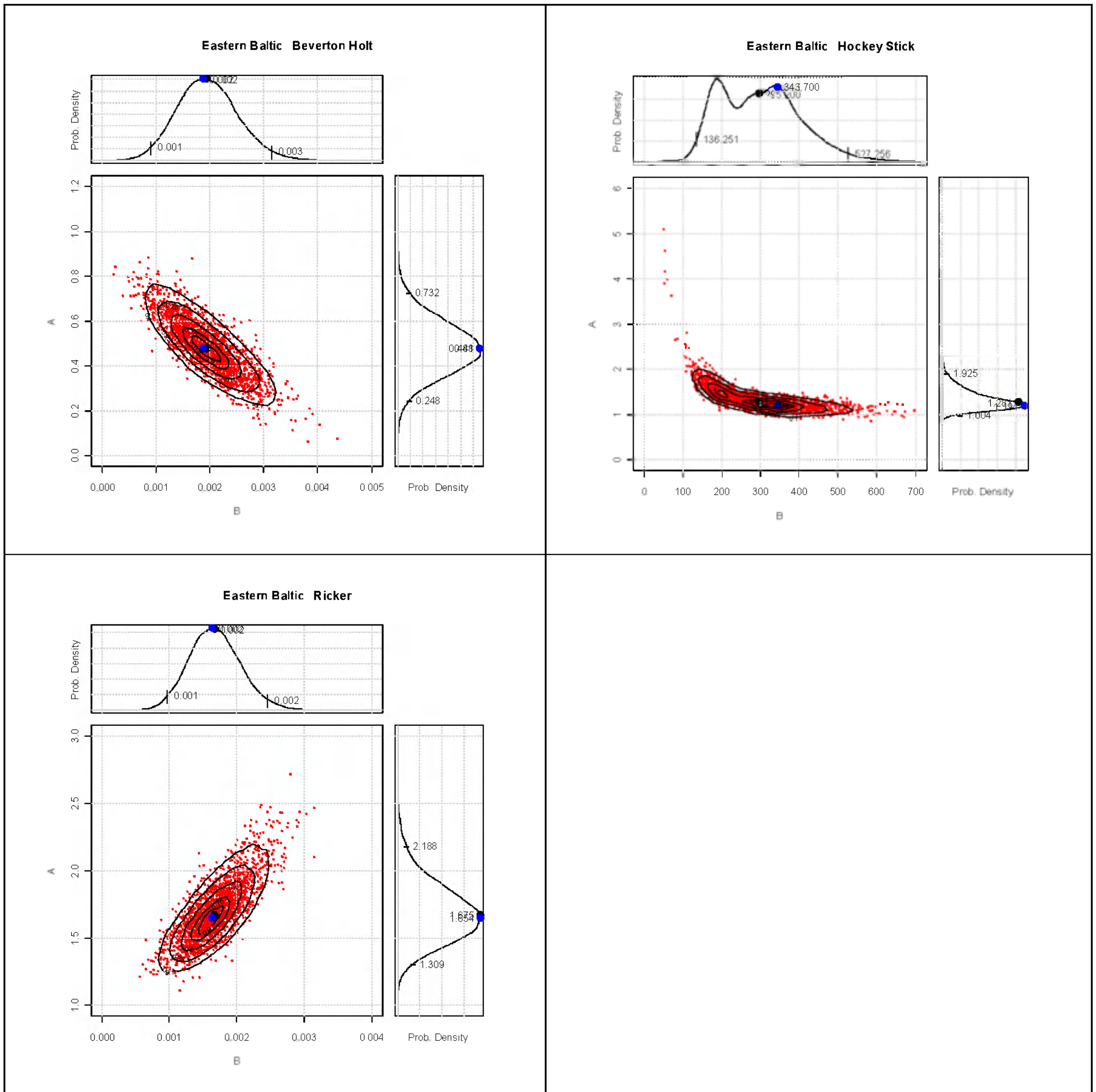

Figure 3. Eastern Baltic cod full timeseries Parameter values for S-R Bayesian independent parameter fits for a) Beverton Holt, b) Hockey stick and c) Ricker functional relationships. Parameters A and B as defined in Table 2. black dots are median values for the fitted parameters and blue dots the parameters giving the maximum likelihood models.

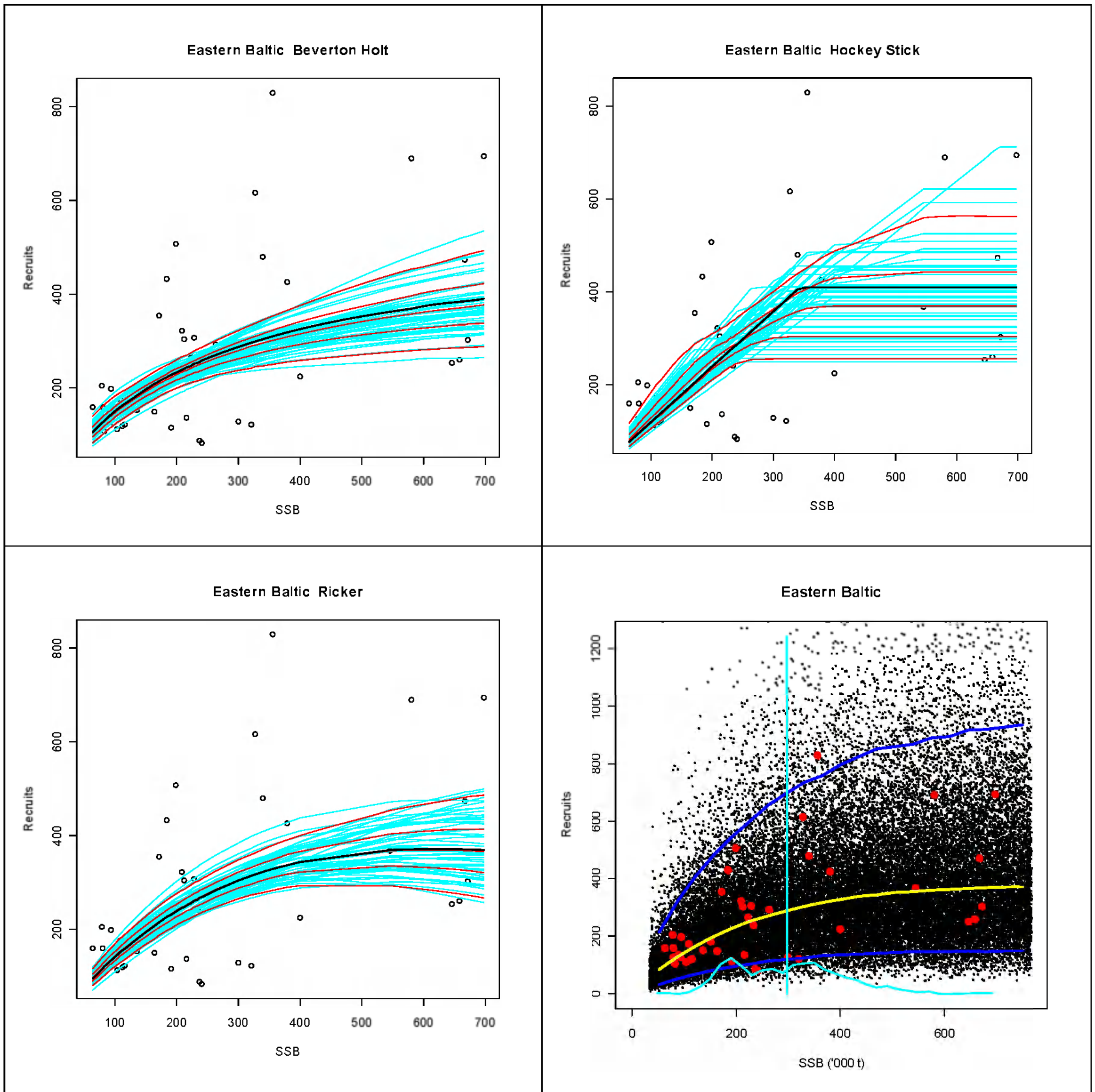

Figure 4. Eastern Baltic cod full timeseries S-R models with Bayesian independent parameter fits and simulated values for a) Beverton Holt, b) Hockey stick and c) Ricker functional relationships individually and d) combined simulated values. Panels a,b,c) S-R observations from ICES assessments (o); 50 randomly selected models (cyan lines); Quantiles of modeled mean R at 5,25,50,75,95% (red lines). For panel d) S-R observations from ICES assessments (●); simulated values using 35, 60,5 % of BH,HS,R models (•) median (yellow) and 5,95% (blue) .Distribution of Blim from HS model and median value (Cyan)

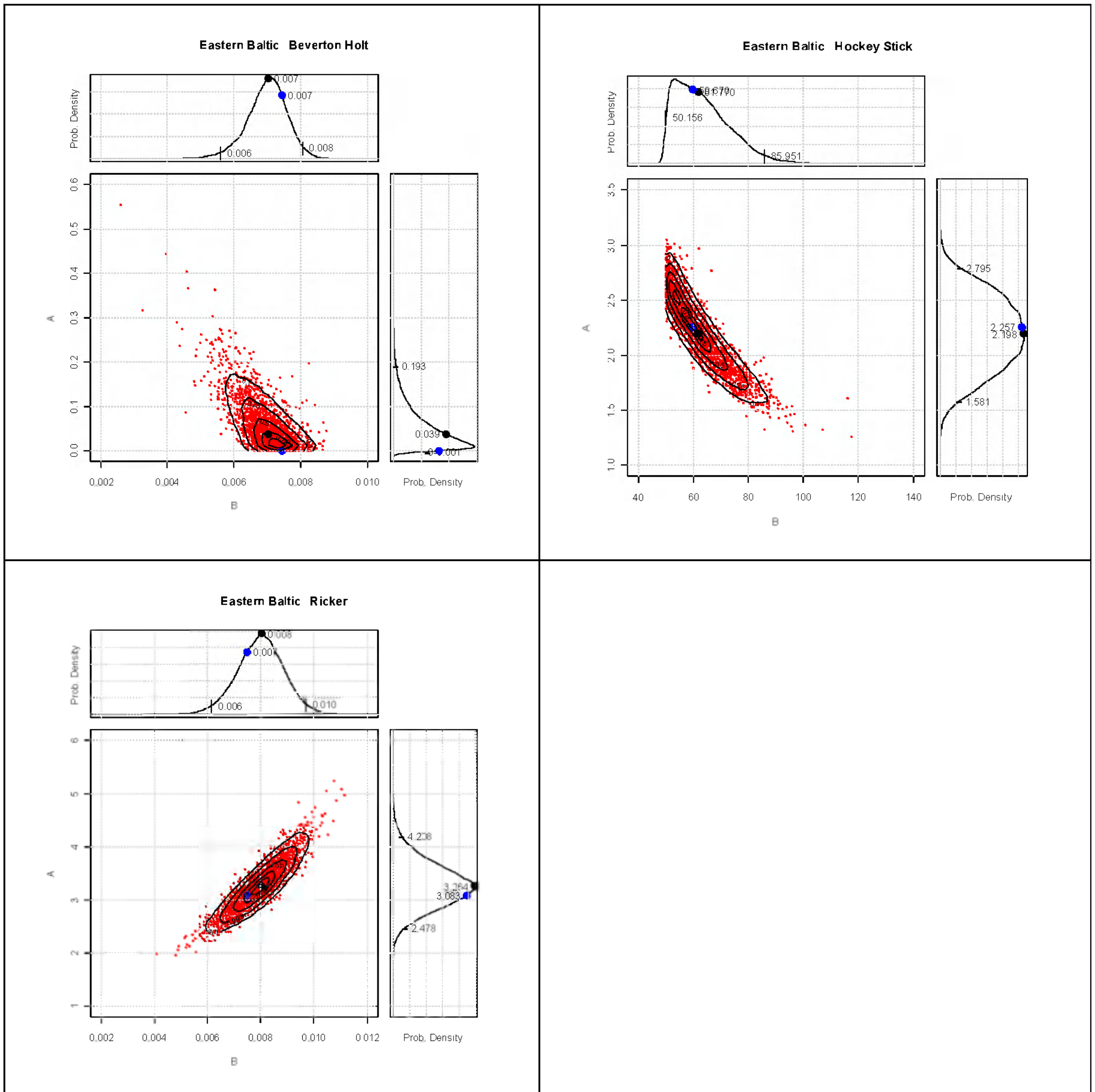

Figure 5. Eastern Baltic cod mid timeseries Parameter values for S-R Bayesian independent parameter fits for a) Beverton Holt, b) Hockey stick and c) Ricker functional relationships. Parameters A and B as defined in Table 2. black dots are median values for the fitted parameters and blue dots the parameters giving the maximum likelihood models.

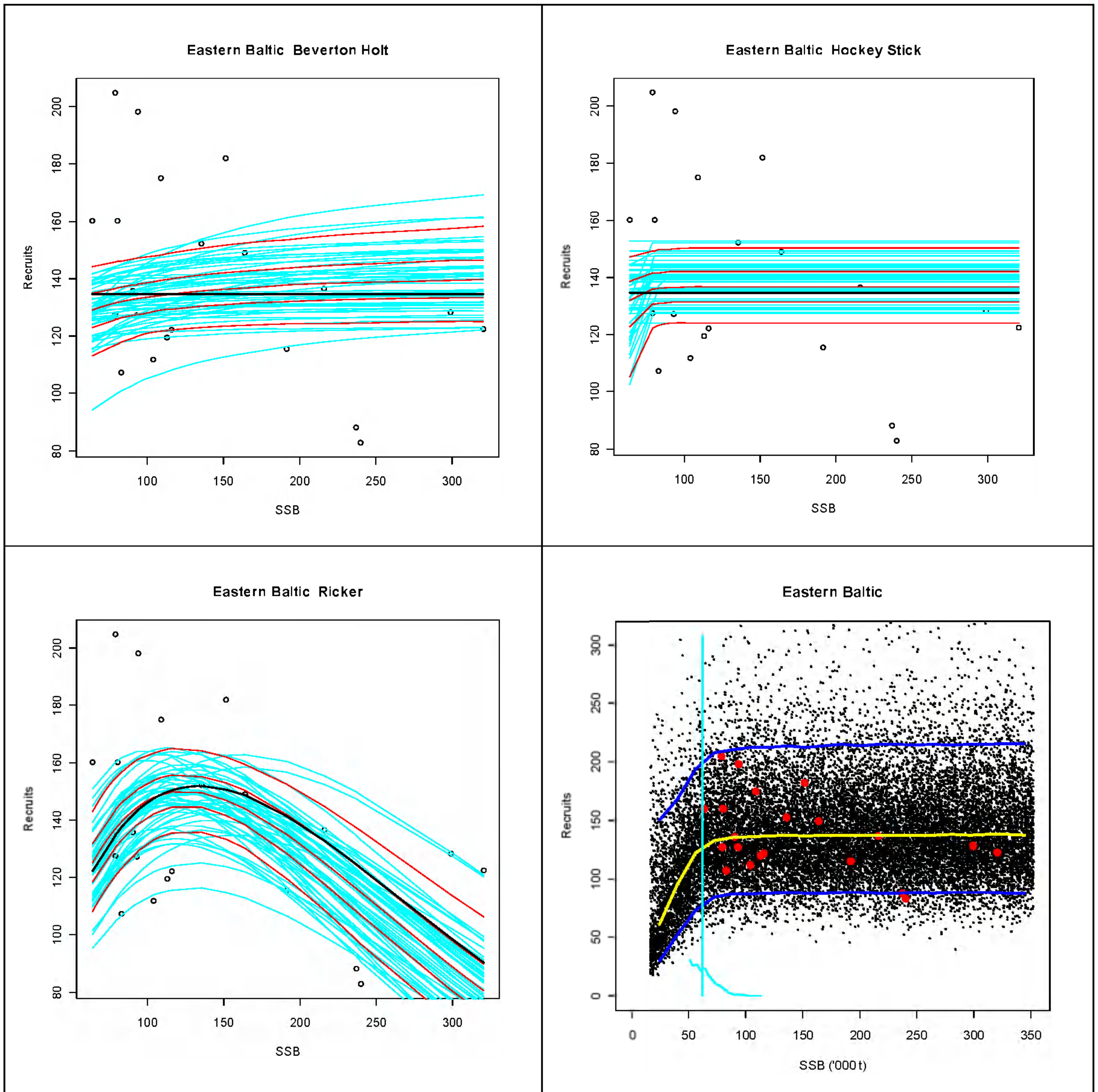

Figure 6. Eastern Baltic cod mid timeseries S-R models with Bayesian independent parameter fits and simulated values for a) Beverton Holt, b) Hockey stick and c) Ricker functional relationships individually and d) combined simulated values. Panels a,b,c) S-R observations from ICES assessments (o); 50 randomly selected models (cyan lines); Quantiles of modeled mean R at 5,25,50,75,95% (red lines). For panel d) S-R observations from ICES assessments (●); simulated values using 35, 60,5 % of BH,HS,R models (•) median (yellow) and 5,95% (blue) .Distribution of Blim from HS model and median value (Cyan)

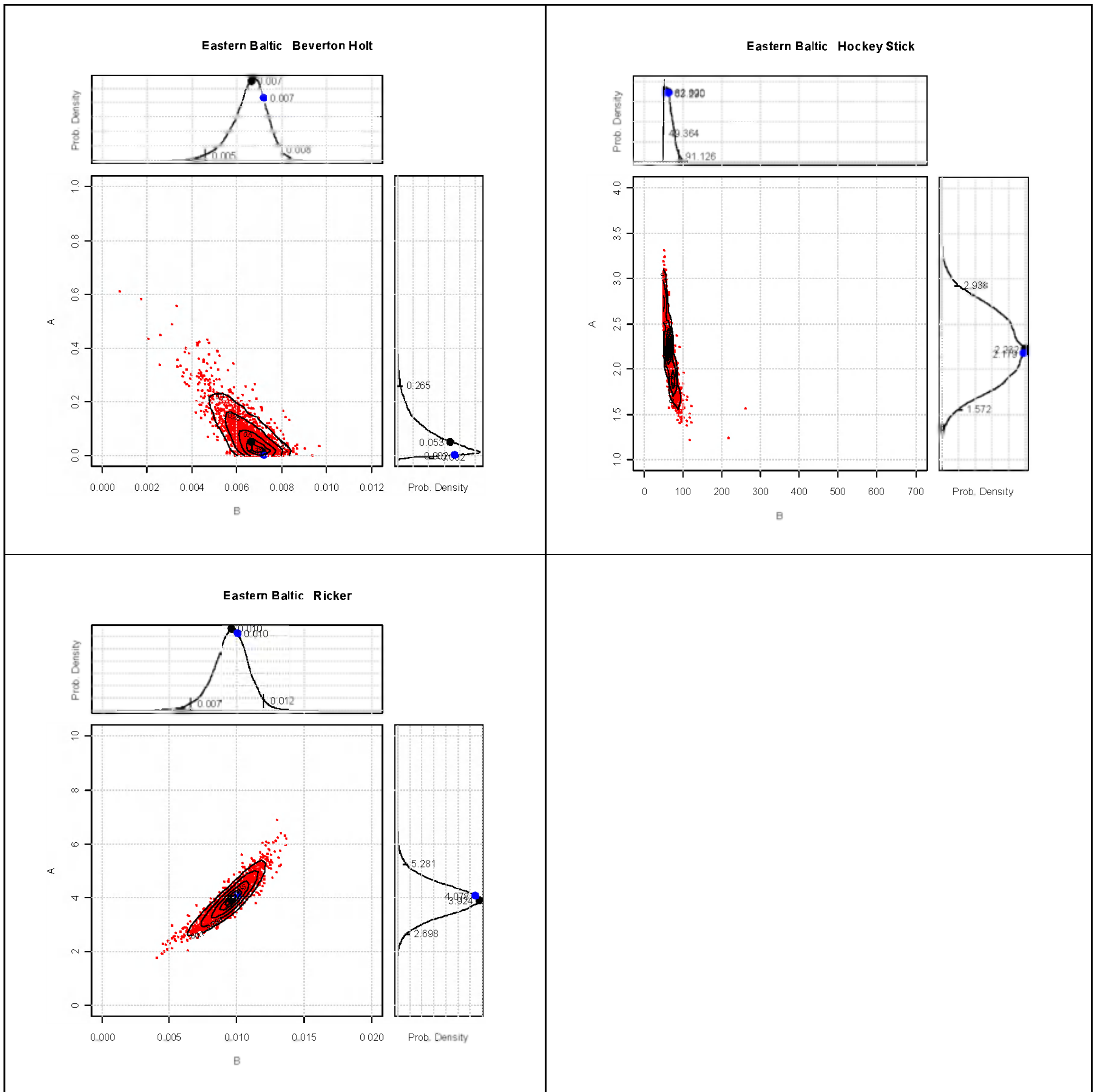

Figure 7. Eastern Baltic cod recent timeseries Parameter values for S-R Bayesian independent parameter fits for a) Beverton Holt, b) Hockey stick and c) Ricker functional relationships. Parameters A and B as defined in Table 2. black dots are median values for the fitted parameters and blue dots the parameters giving the maximum likelihood models.

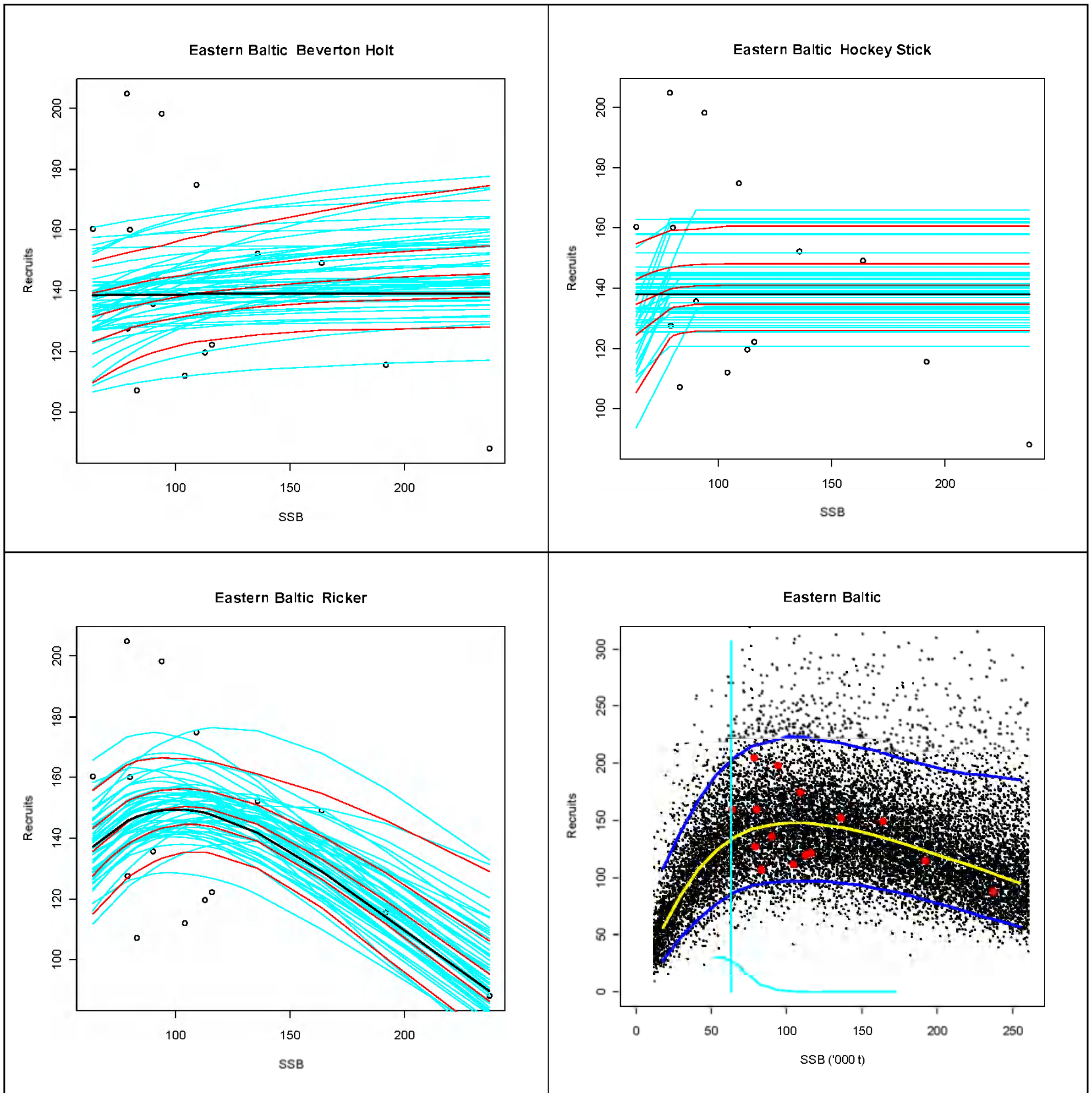

Figure 8. Eastern Baltic cod recent timeseries S-R models with Bayesian independent parameter fits and simulated values for a) Beverton Holt, b) Hockey stick and c) Ricker functional relationships individually and d) combined simulated values. Panels a,b,c) S-R observations from ICES assessments (o); 50 randomly selected models (cyan lines); Quantiles of modeled mean R at 5,25,50,75,95% (red lines). For panel d) S-R observations from ICES assessments (●); simulated values using 35, 60,5 % of BH,HS,R models (•) median (yellow) and 5,95% (blue) .Distribution of Blim from HS model and median value (Cyan)

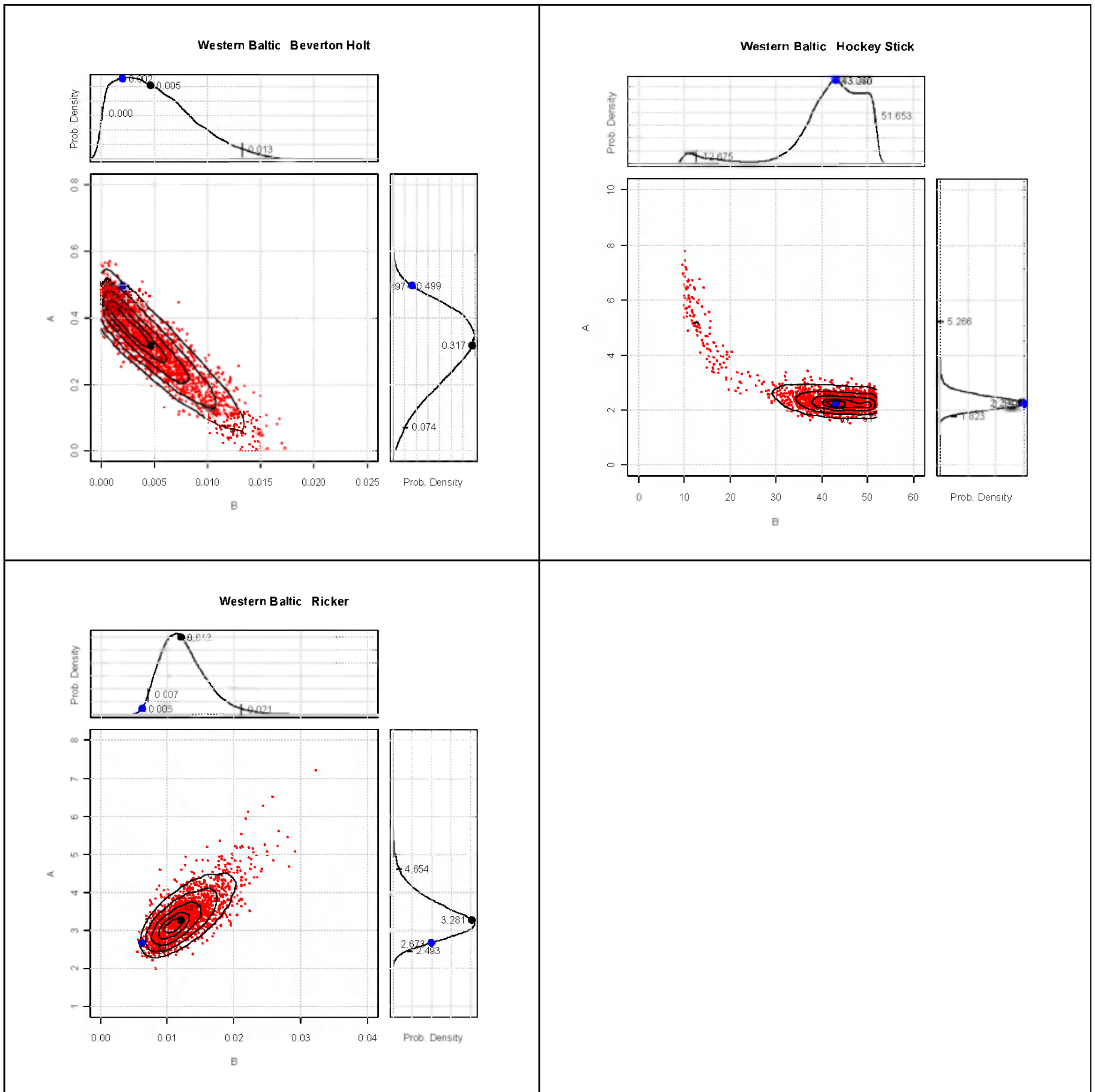

Figure 9. Western Baltic cod full timeseries Parameter values for S-R Bayesian independent parameter fits for a) Beverton Holt, b) Hockey stick and c) Ricker functional relationships. Parameters A and B as defined in Table 2. black dots are median values for the fitted parameters and blue dots the parameters giving the maximum likelihood models.

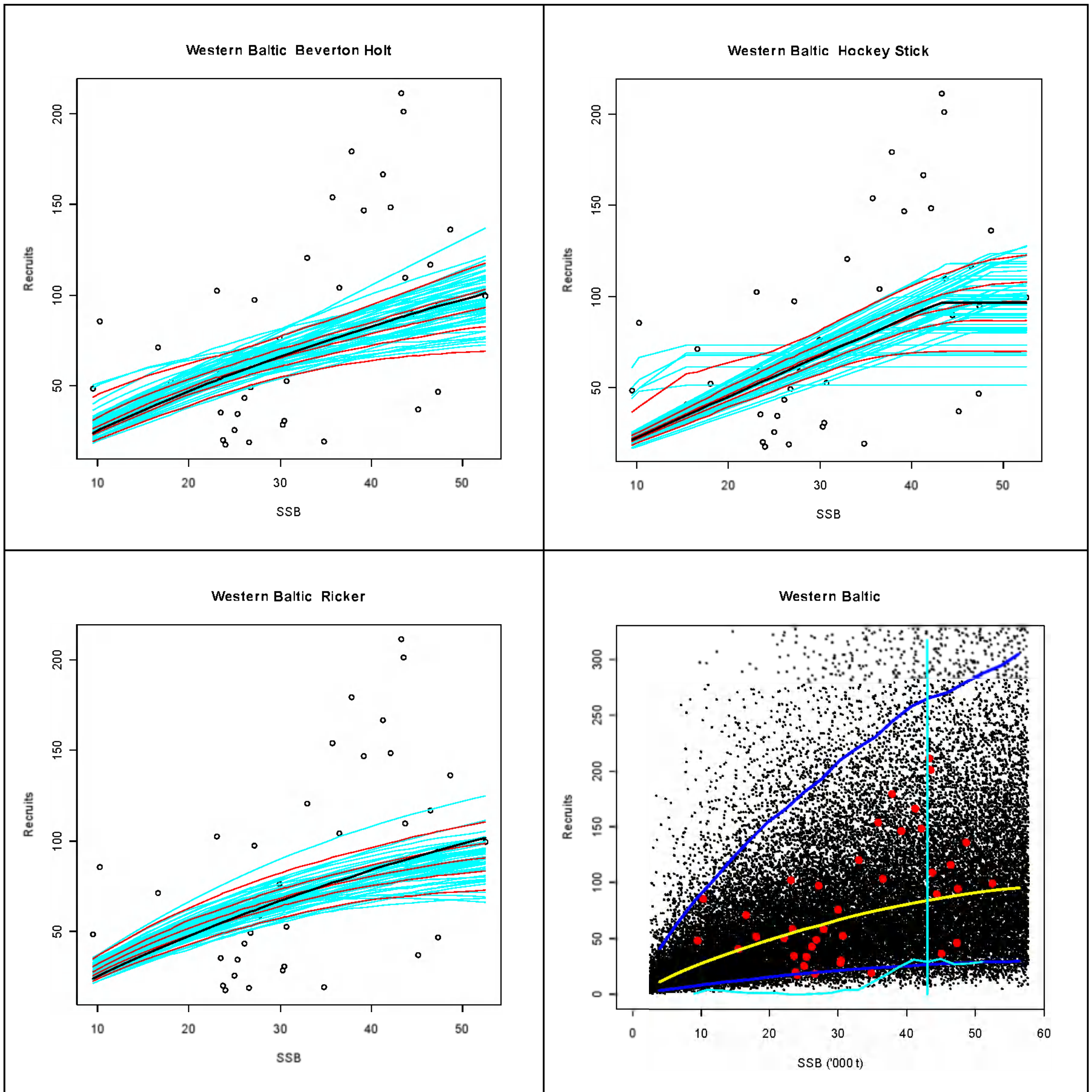

Figure 10. Western Baltic cod full timeseries S-R models with Bayesian independent parameter fits and simulated values for a) Beverton Holt, b) Hockey stick and c) Ricker functional relationships individually and d) combined simulated values. Panels a,b,c) S-R observations from ICES assessments (o); 50 randomly selected models (cyan lines); Quantiles of modeled mean R at 5,25,50,75,95% (red lines). For panel d) S-R observations from ICES assessments (●); simulated values using 35, 60,5 % of BH,HS,R models (•) median (yellow) and 5,95% (blue) .Distribution of Blim from HS model and median value (Cyan)

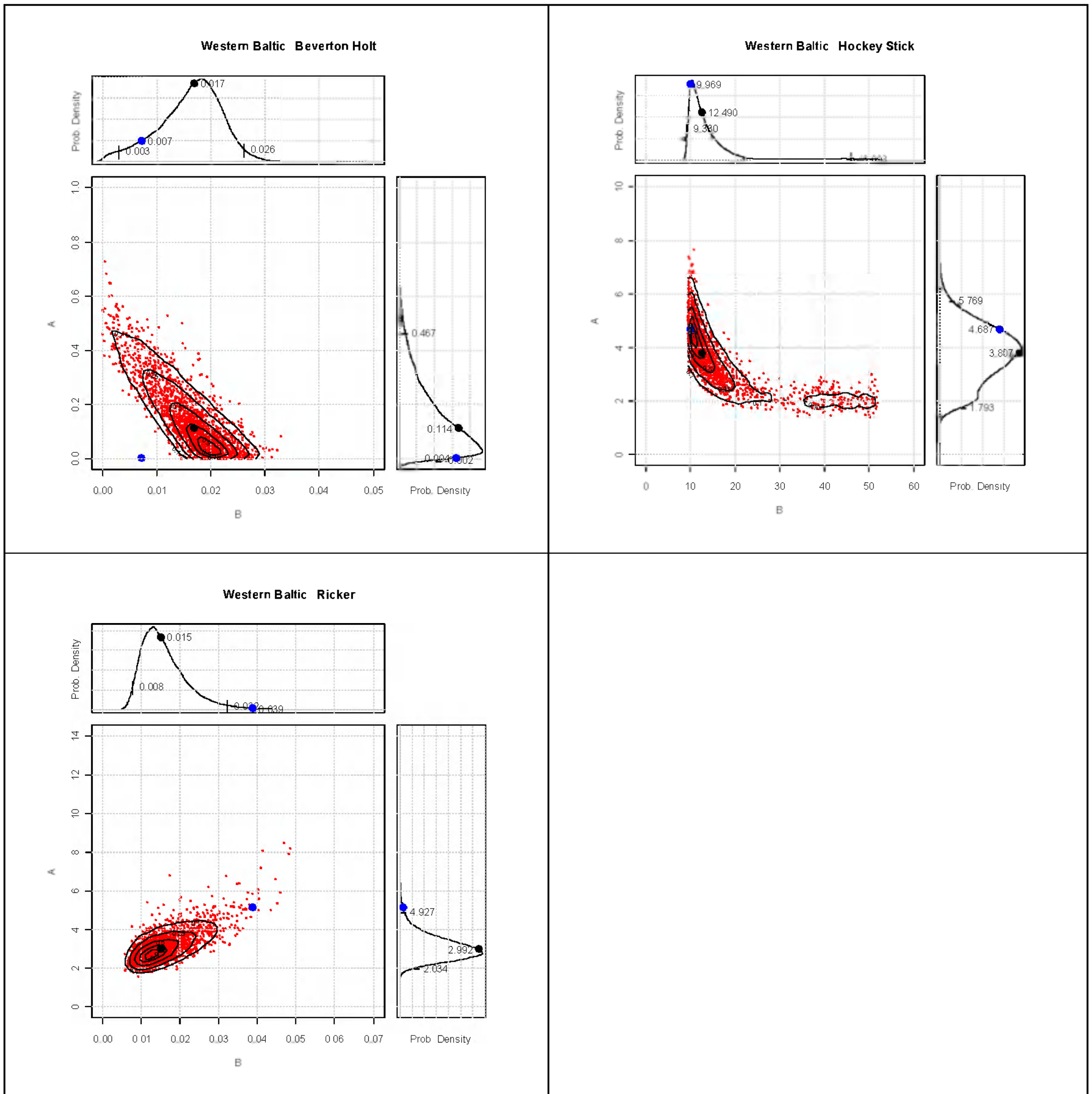

Figure 11. Western Baltic cod mid timeseries Parameter values for S-R Bayesian independent parameter fits for a) Beverton Holt, b) Hockey stick and c) Ricker functional relationships. Parameters A and B as defined in Table 2. black dots are median values for the fitted parameters and blue dots the parameters giving the maximum likelihood models.

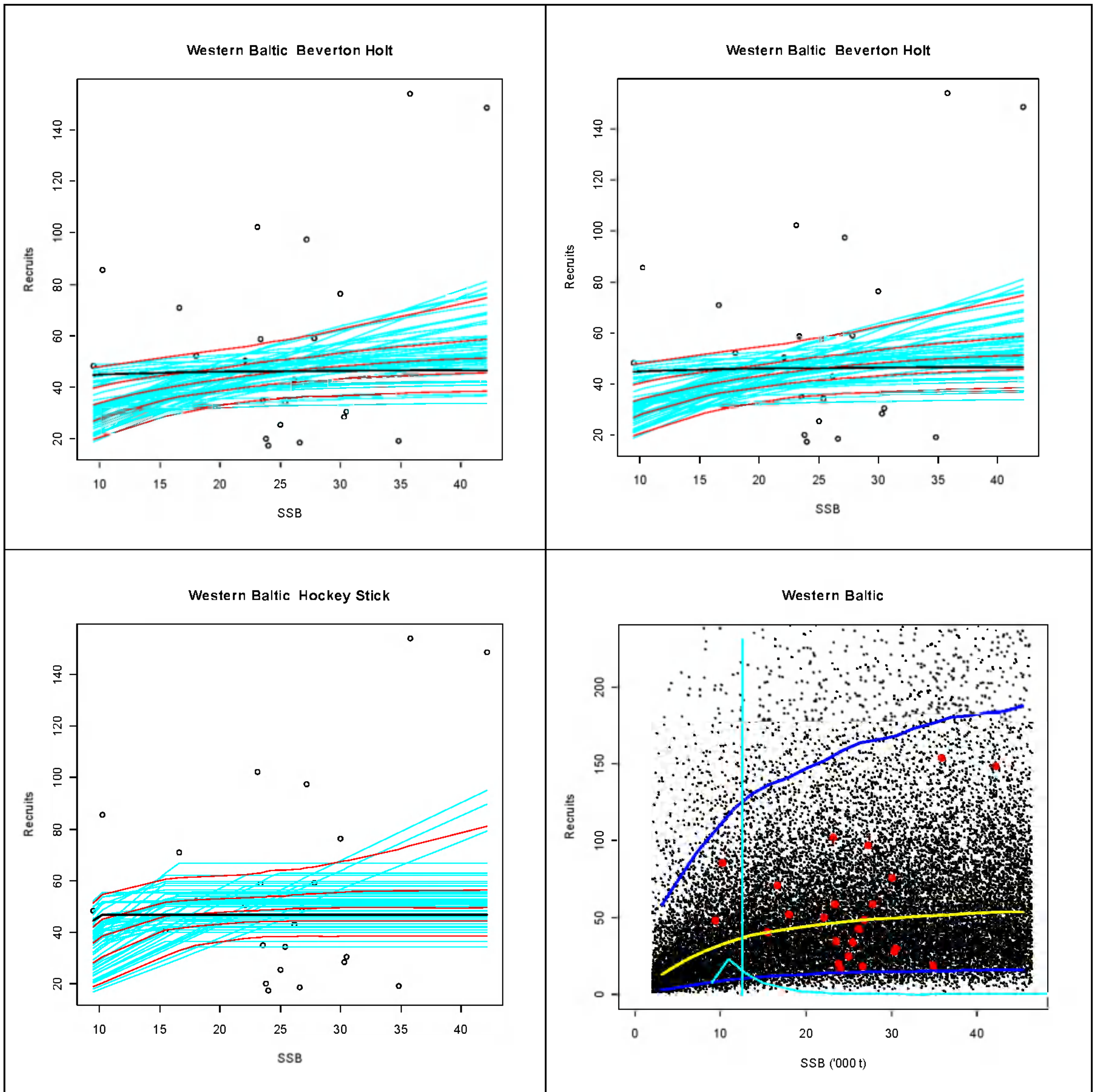

Figure 12. Western Baltic cod mid timeseries S-R models with Bayesian independent parameter fits and simulated values for a) Beverton Holt, b) Hockey stick and c) Ricker functional relationships individually and d) combined simulated values. Panels a,b,c) S-R observations from ICES assessments (o); 50 randomly selected models (cyan lines); Quantiles of modeled mean R at 5,25,50,75,95% (red lines). For panel d) S-R observations from ICES assessments (●); simulated values using 35, 60,5 % of BH,HS,R models (•) median (yellow) and 5,95% (blue) .Distribution of Blim from HS model and median value (Cyan)

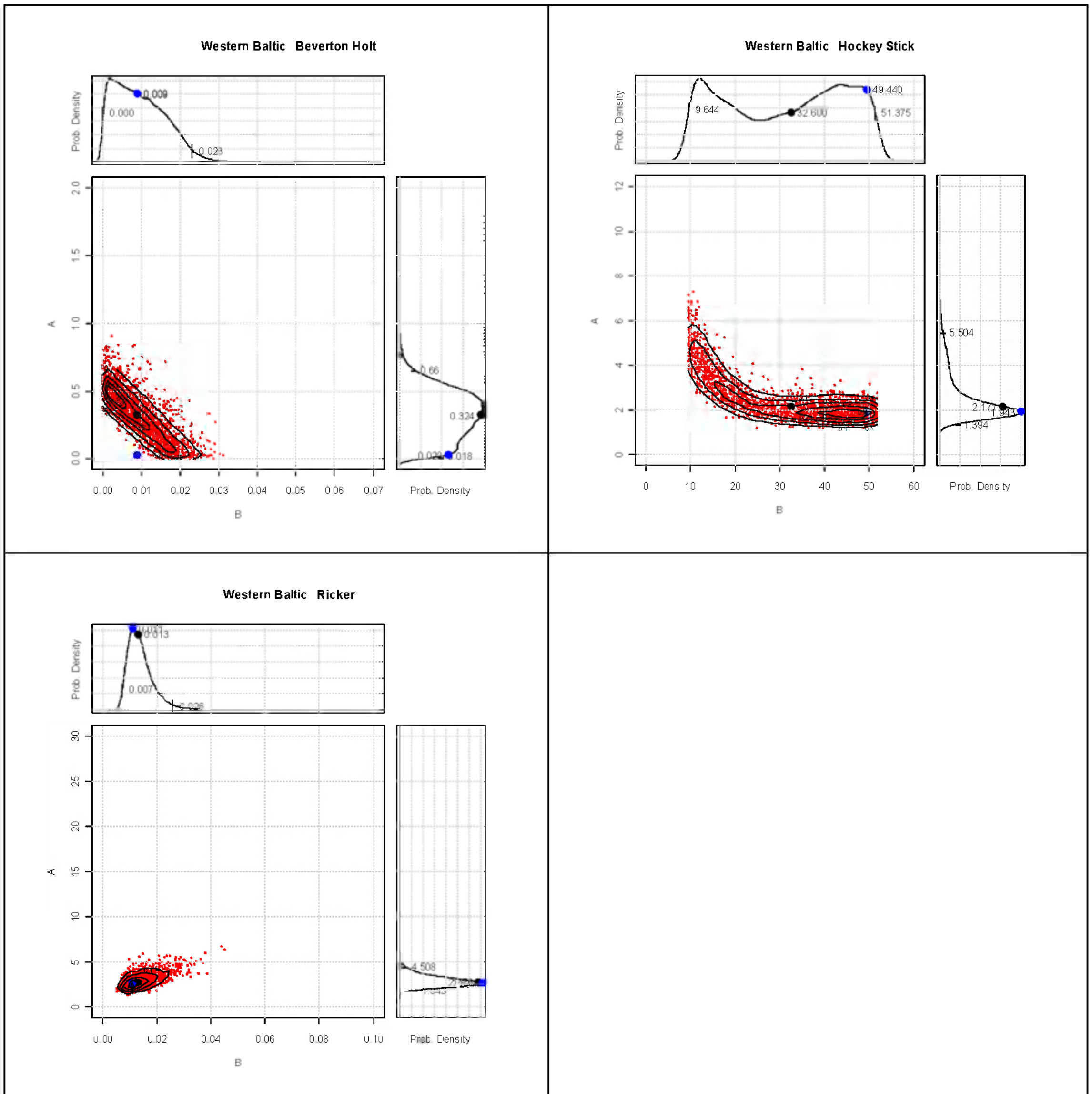

Figure 13. Western Baltic cod recent timeseries Parameter values for S-R Bayesian independent parameter fits for a) Beverton Holt, b) Hockey stick and c) Ricker functional relationships. Parameters A and B as defined in Table 2. black dots are median values for the fitted parameters and blue dots the parameters giving the maximum likelihood models.

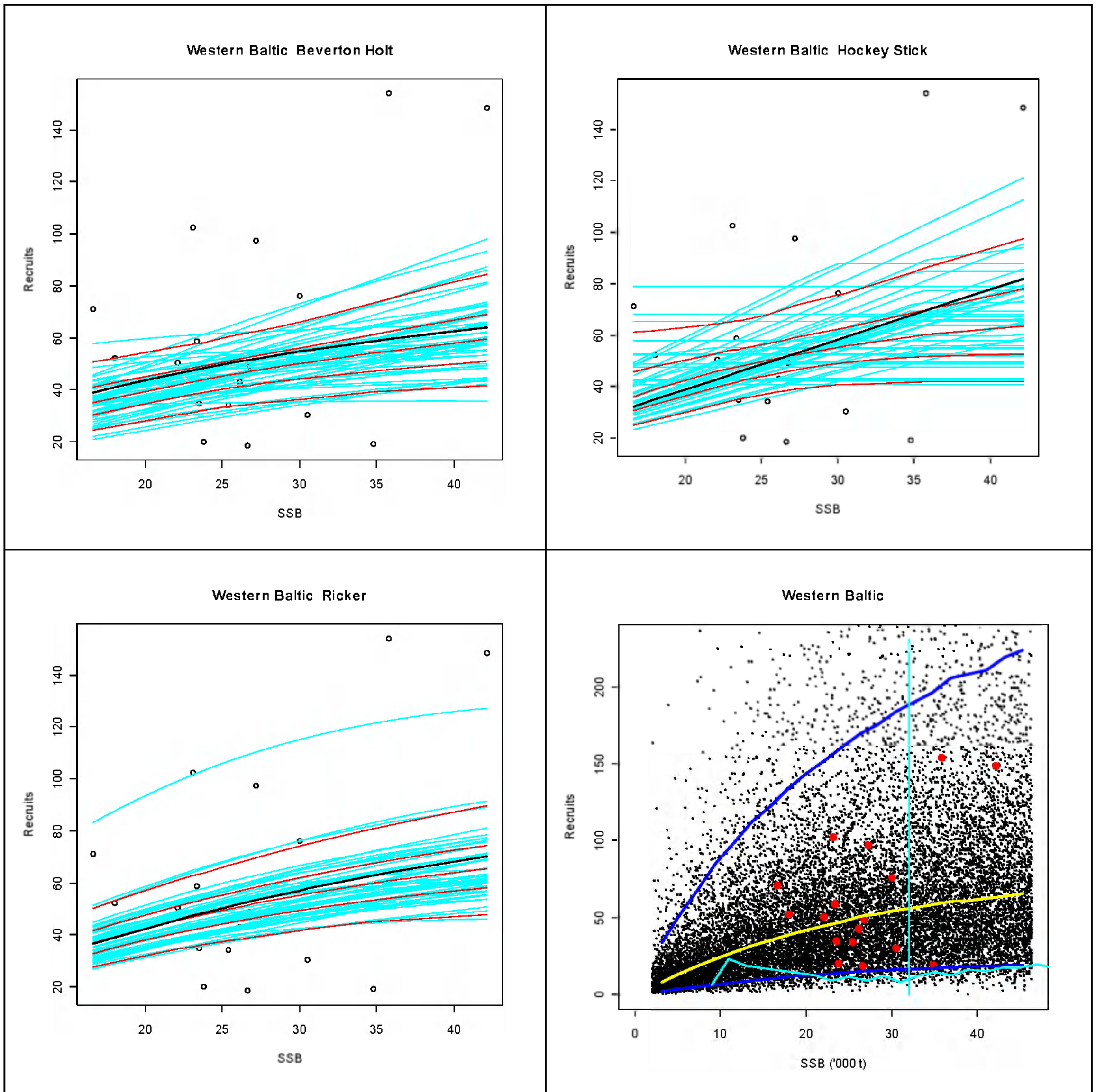

Figure 14. Western Baltic cod recent timeseries S-R models with Bayesian independent parameter fits and simulated values for a) Beverton Holt, b) Hockey stick and c) Ricker functional relationships individually and d) combined simulated values. Panels a,b,c) S-R observations from ICES assessments (o); 50 randomly selected models (cyan lines); Quantiles of modeled mean R at 5,25,50,75,95% (red lines). For panel d) S-R observations from ICES assessments (●); simulated values using 35, 60,5 % of BH,HS,R models (•) median (yellow) and 5,95% (blue) .Distribution of Blim from HS model and median value (Cyan)

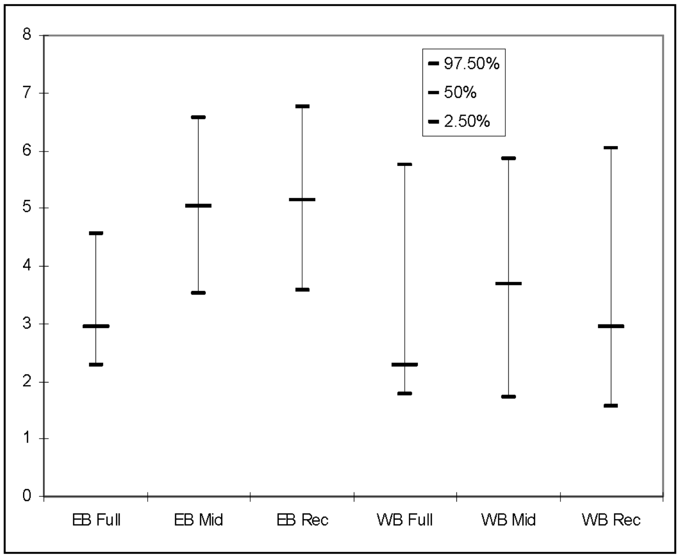

Fig 15 Comparison of slope to the origin for HS models (taking into account the M=0.8 for Western cod.)

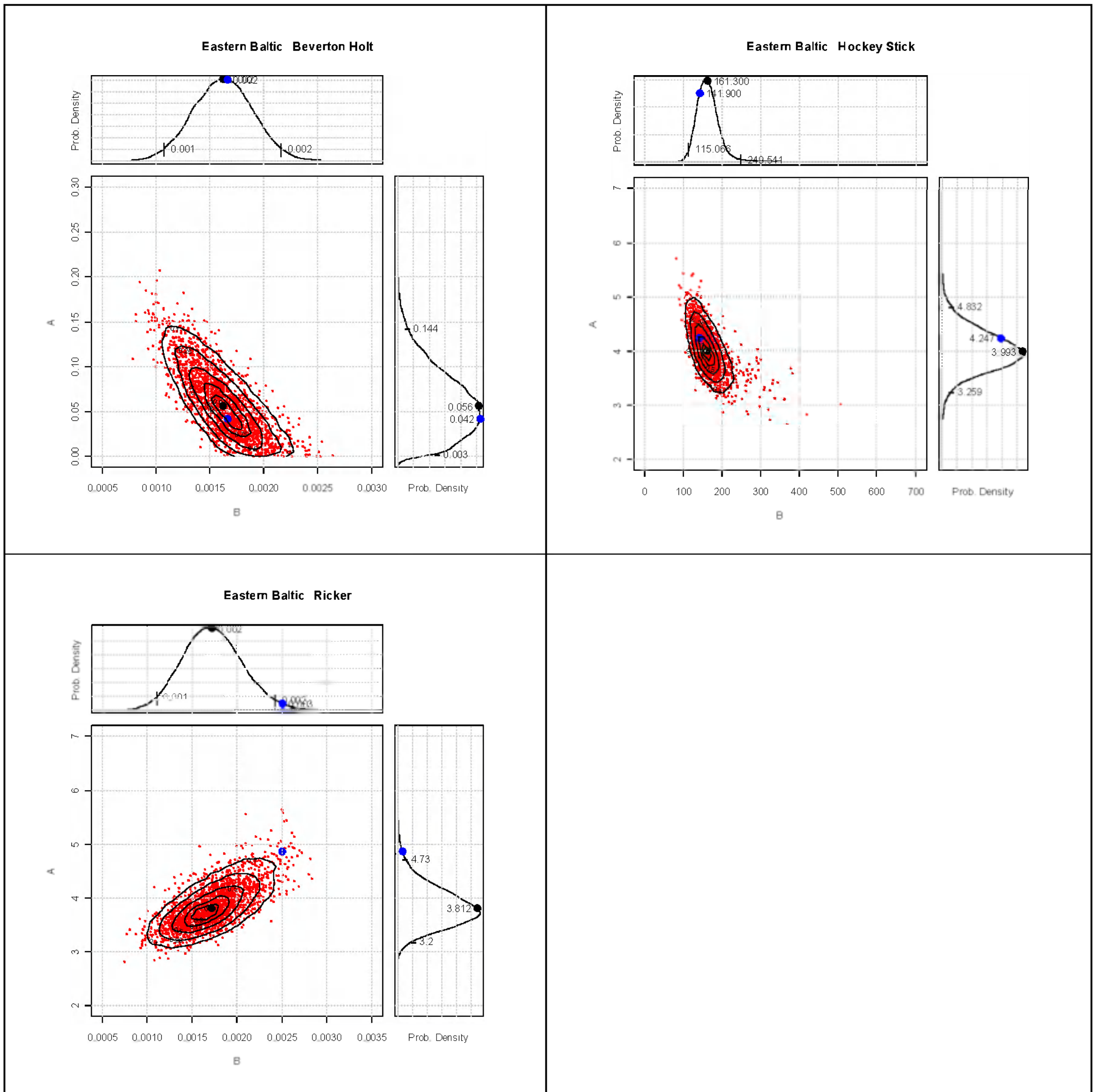

Figure 16. Eastern Baltic cod full timeseries Parameter values for S-R Bayesian fits with A common across stock and period and independent B parameters for a) Beverton Holt, b) Hockey stick and c) Ricker functional relationships. Parameters A and B as defined in Table 2. black dots are median values for the fitted parameters and blue dots the parameters giving the maximum likelihood models.

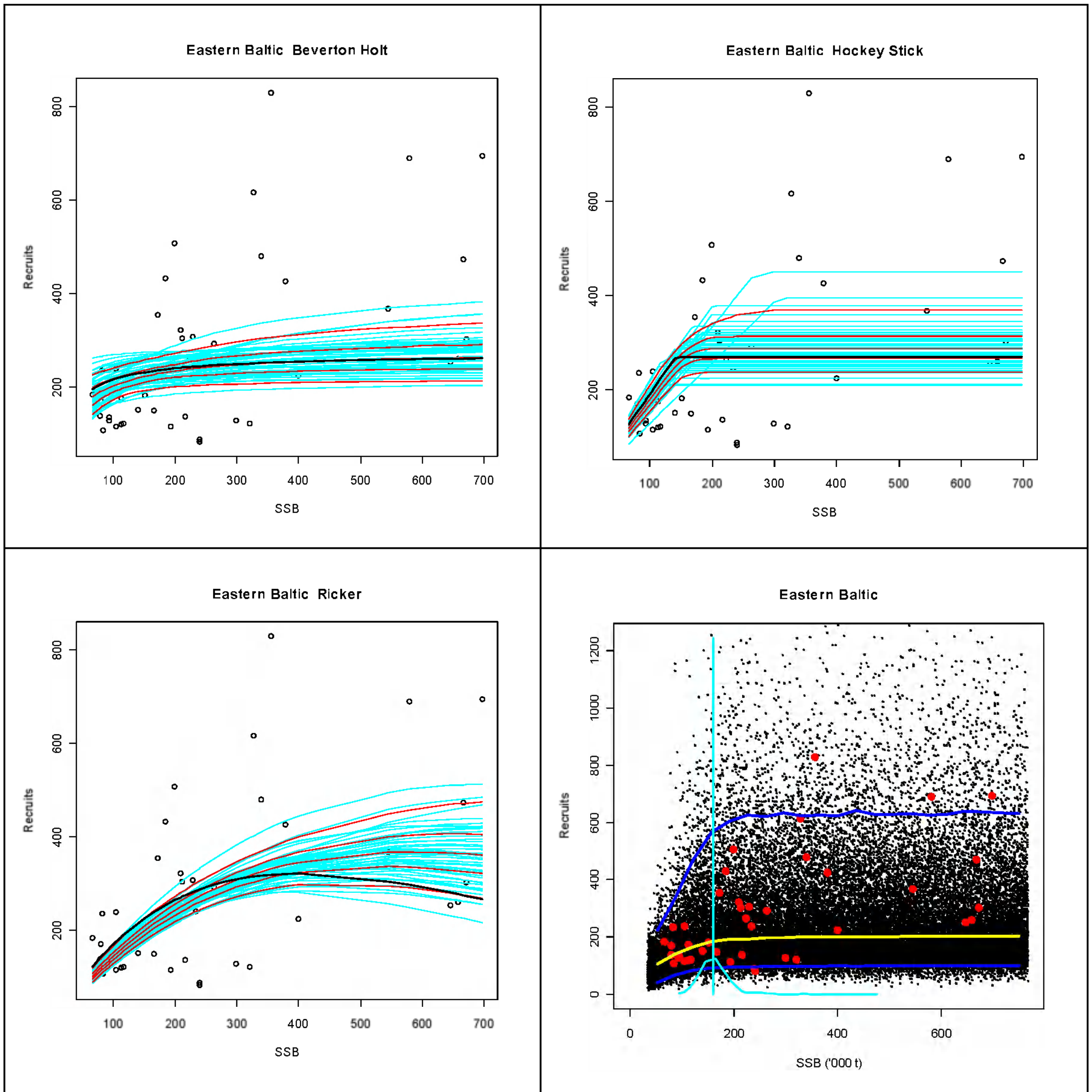

Figure 17. Eastern Baltic cod full timeseries S-R models with Bayesian fits with A common across stock and period and independent B parameters and simulated values for a) Beverton Holt, b) Hockey stick and c) Ricker functional relationships individually and d) combined simulated values. Panels a,b,c) S-R observations from ICES assessments (o); 50 randomly selected models (cyan lines); Quantiles of modeled mean R at 5,25,50,75,95% (red lines). For panel d) S-R observations from ICES assessments (●); simulated values using 35, 60,5 % of BH,HS,R models (•) median (yellow) and 5,95% (blue) .Distribution of Blim from HS model and median value (Cyan)

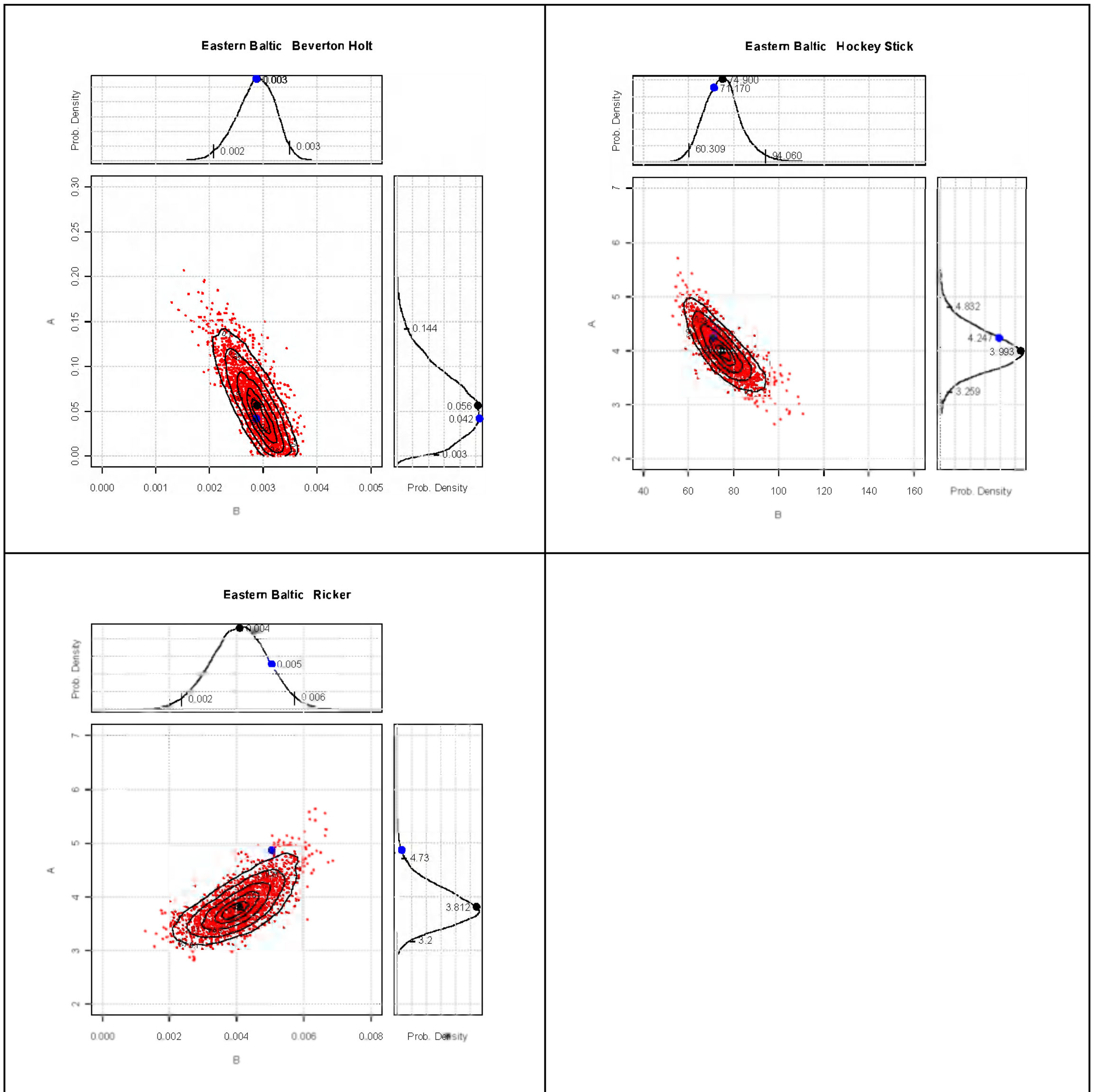

Figure 18. Eastern Baltic cod mid timeseries Parameter values for S-R Bayesian fits with A common across stock and period and independent B parameters for a) Beverton Holt, b) Hockey stick and c) Ricker functional relationships. Parameters A and B as defined in Table 2. black dots are median values for the fitted parameters and blue dots the parameters giving the maximum likelihood models.

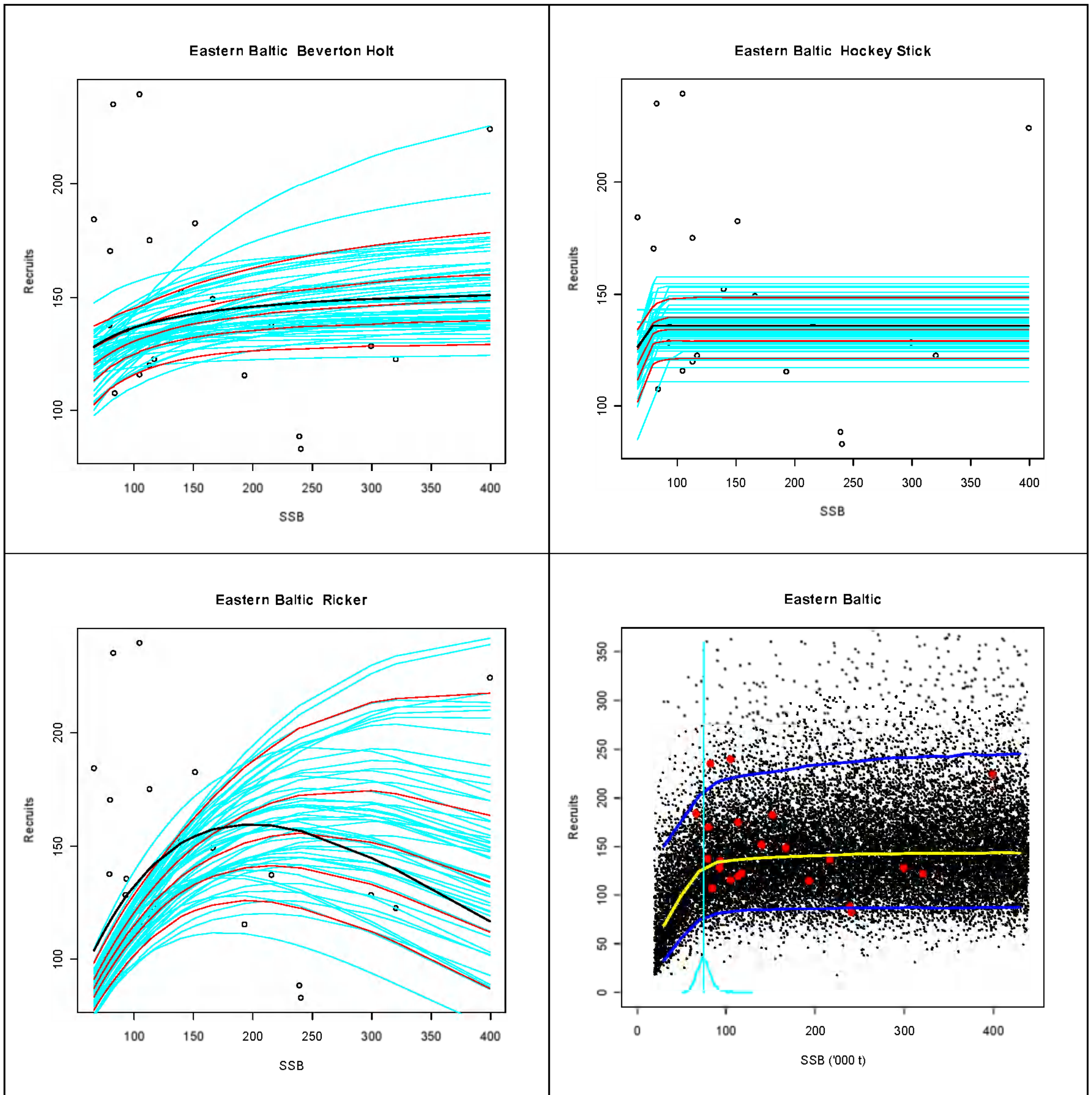

Figure 19. Eastern Baltic cod mid timeseries S-R models with Bayesian fits with A common across stock and period and independent B parameters and simulated values for a) Beverton Holt, b) Hockey stick and c) Ricker functional relationships individually and d) combined simulated values. Panels a,b,c) S-R observations from ICES assessments (o); 50 randomly selected models (cyan lines); Quantiles of modeled mean R at 5,25,50,75,95% (red lines). For panel d) S-R observations from ICES assessments (●); simulated values using 35, 60,5 % of BH,HS,R models (•) median (yellow) and 5,95% (blue) .Distribution of Blim from HS model and median value (Cyan)

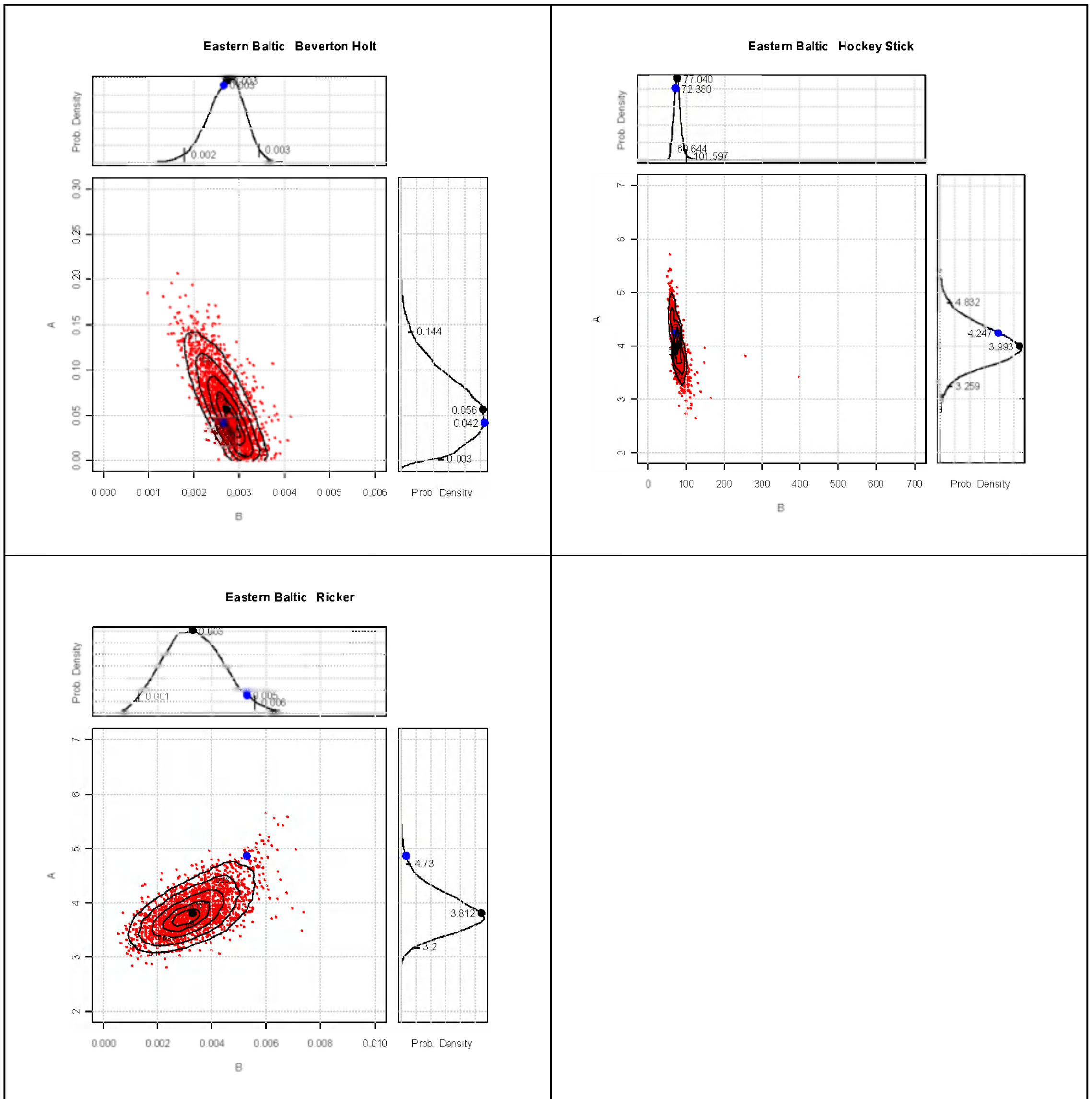

Figure 20. Eastern Baltic cod recent timeseries Parameter values for S-R Bayesian fits with A common across stock and period and independent B parameters for a) Beverton Holt, b) Hockey stick and c) Ricker functional relationships. Parameters A and B as defined in Table 2. black dots are median values for the fitted parameters and blue dots the parameters giving the maximum likelihood models.

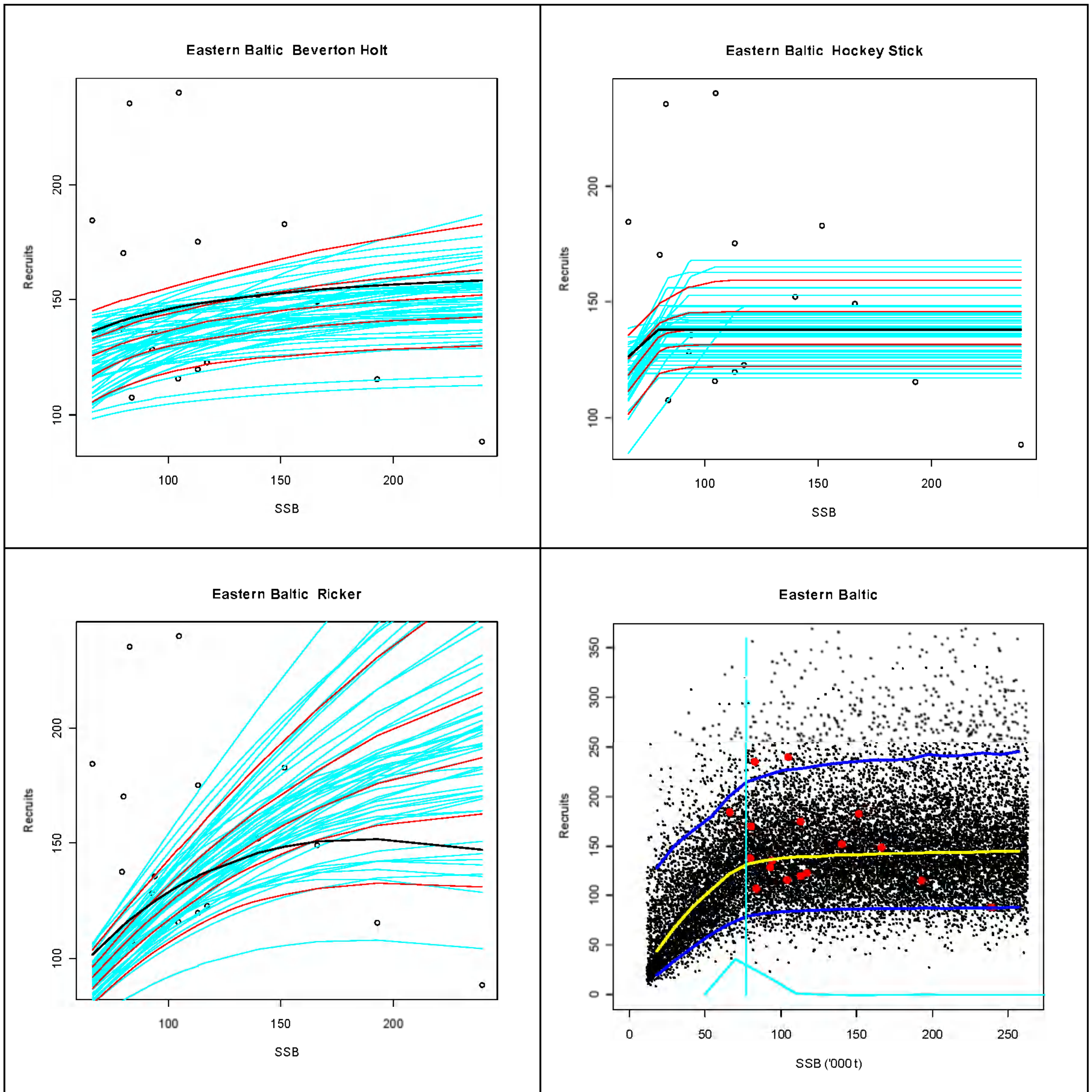

Figure 21. Eastern Baltic cod recent timeseries S-R models with Bayesian fits with A common across stock and period and independent B parameters and simulated values for a) Beverton Holt, b) Hockey stick and c) Ricker functional relationships individually and d) combined simulated values. Panels a,b,c) S-R observations from ICES assessments (o); 50 randomly selected models (cyan lines); Quantiles of modeled mean R at 5,25,50,75,95% (red lines). For panel d) S-R observations from ICES assessments (●); simulated values using 35, 60,5 % of BH,HS,R models (•) median (yellow) and 5,95% (blue) .Distribution of Blim from HS model and median value (Cyan)

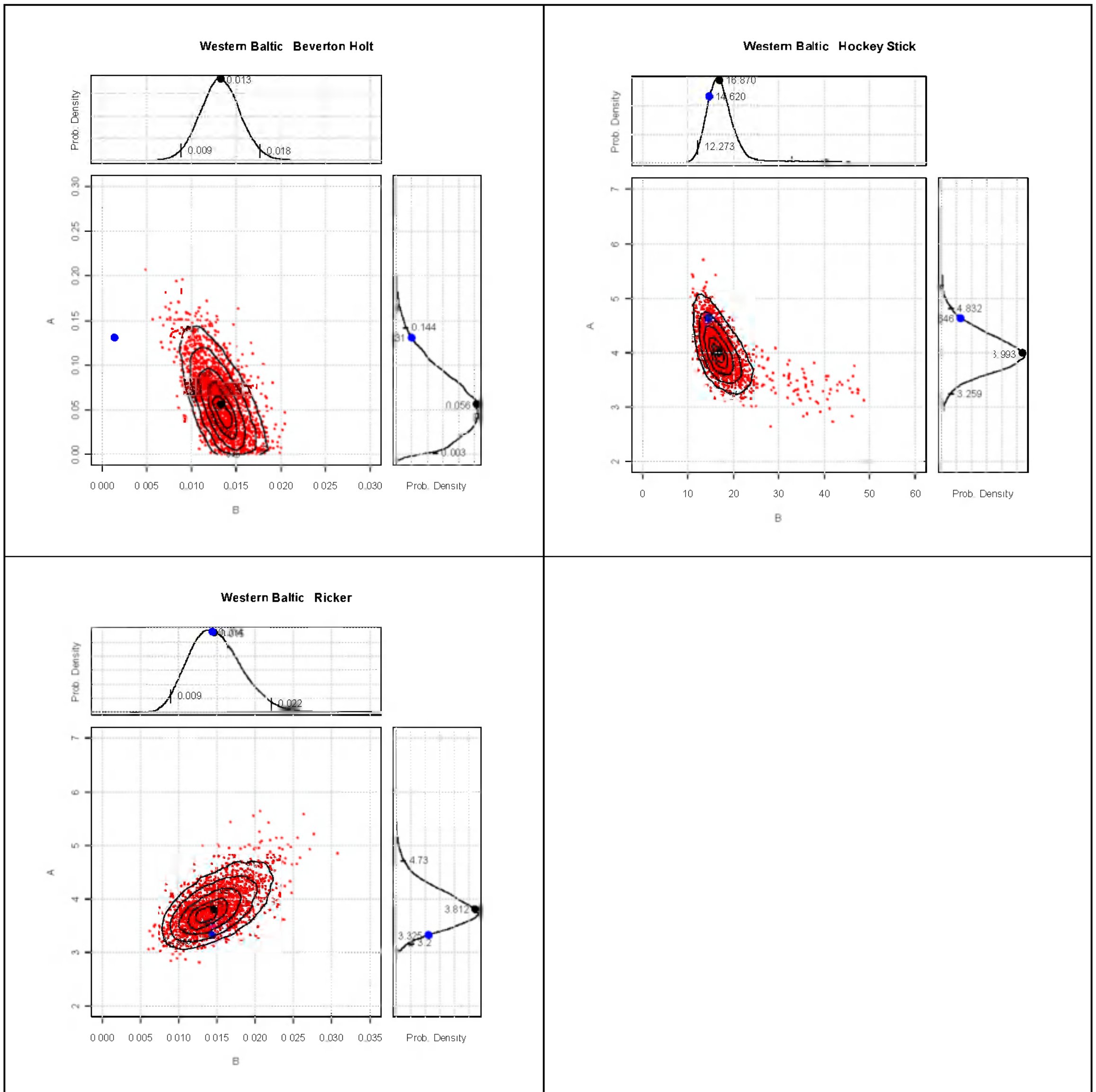

Figure 22. Western Baltic cod full timeseries Parameter values for S-R Bayesian fits with A common across stock and period and independent B parameters for a) Beverton Holt, b) Hockey stick and c) Ricker functional relationships. Parameters A and B as defined in Table 2. black dots are median values for the fitted parameters and blue dots the parameters giving the maximum likelihood models.

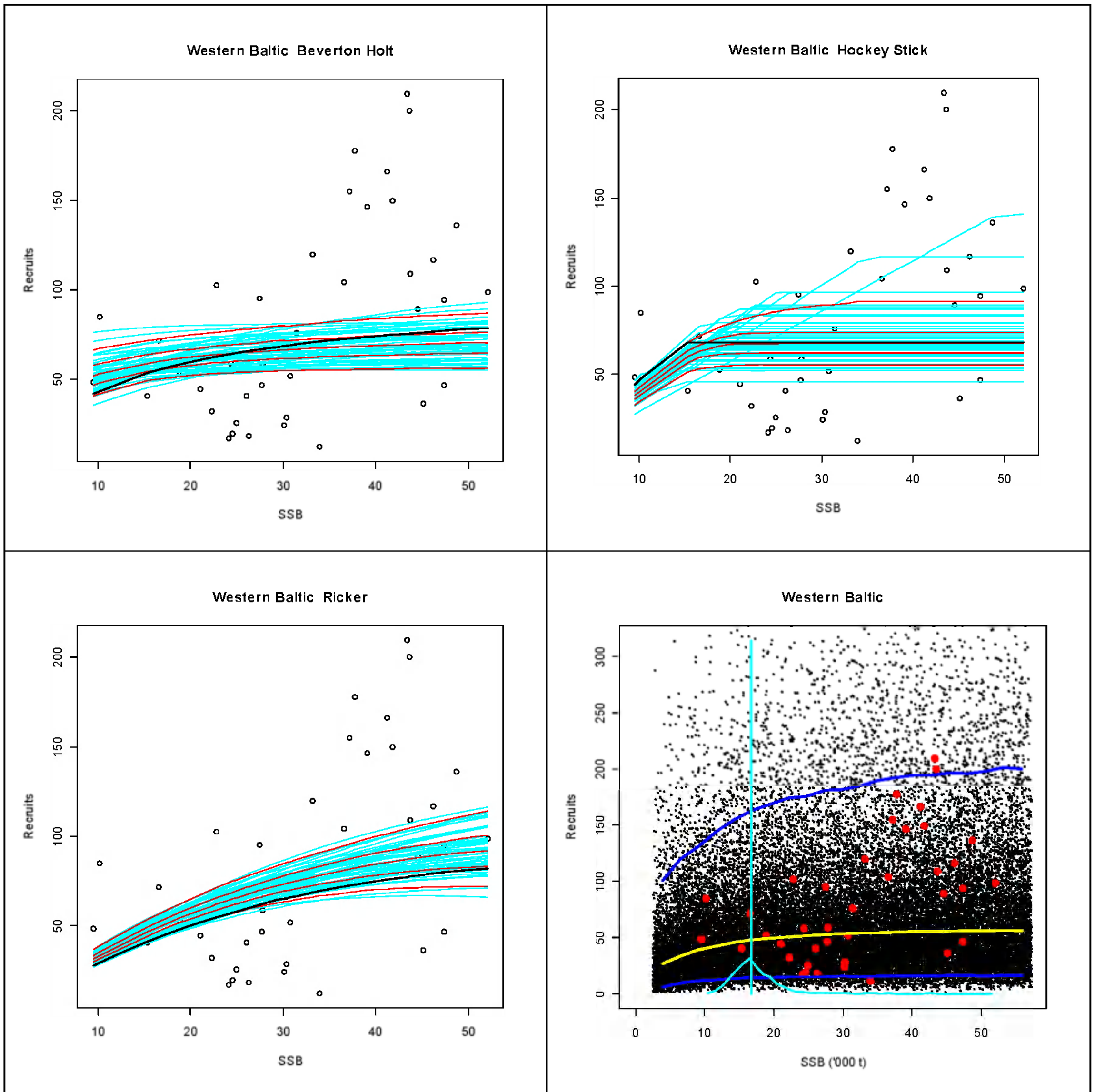

Figure 23. Western Baltic cod full timeseries S-R models with Bayesian fits with A common across stock and period and independent B parameters and simulated values for a) Beverton Holt, b) Hockey stick and c) Ricker functional relationships individually and d) combined simulated values. Panels a,b,c) S-R observations from ICES assessments (o); 50 randomly selected models (cyan lines); Quantiles of modeled mean R at 5,25,50,75,95% (red lines). For panel d) S-R observations from ICES assessments (●); simulated values using 35, 60,5 % of BH,HS,R models (•) median (yellow) and 5,95% (blue) .Distribution of Blim from HS model and median value (Cyan)

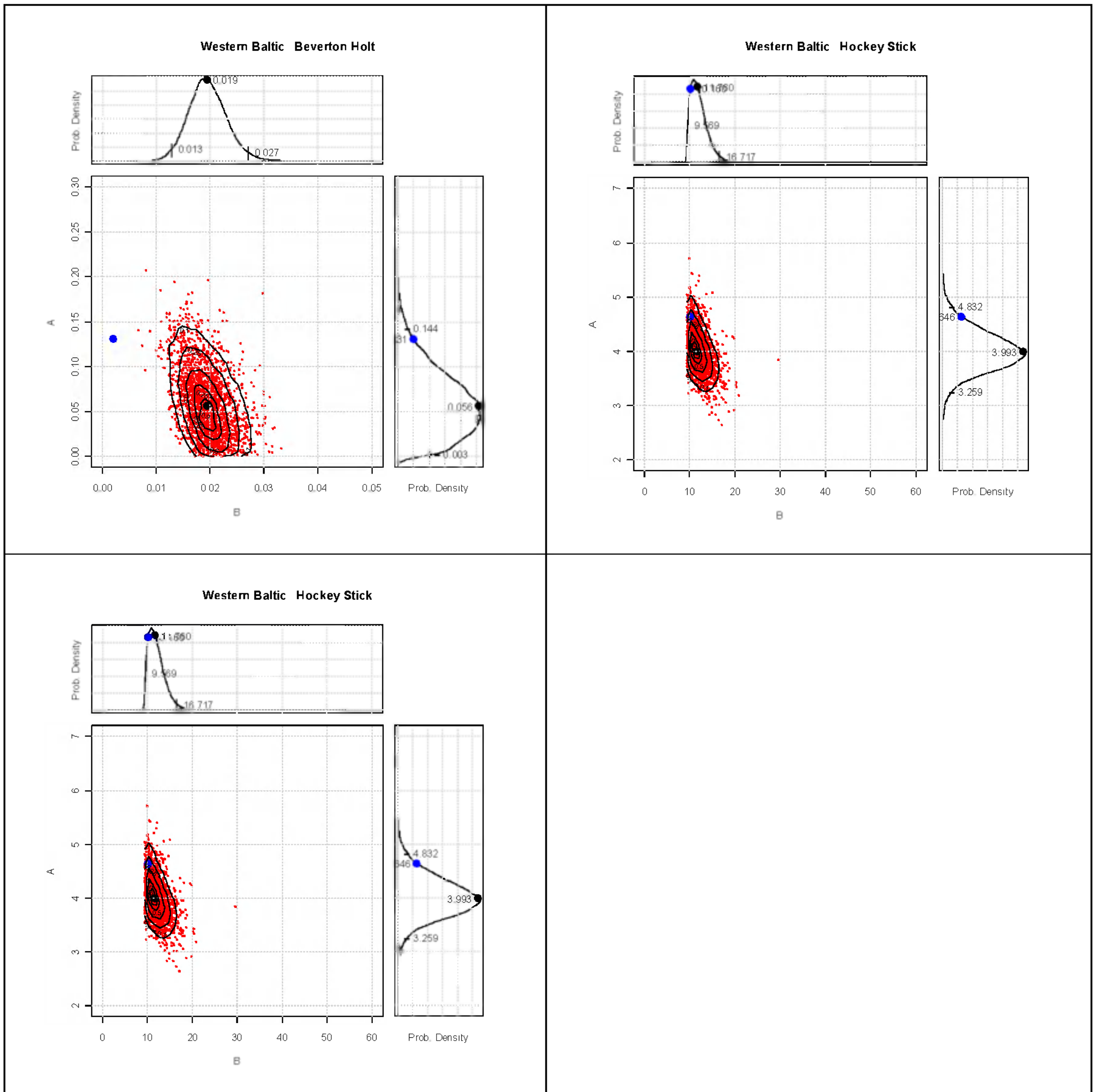

Figure 24. Western Baltic cod mid timeseries Parameter values for S-R Bayesian fits with A common across stock and period and independent B parameters for a) Beverton Holt, b) Hockey stick and c) Ricker functional relationships. Parameters A and B as defined in Table 2. black dots are median values for the fitted parameters and blue dots the parameters giving the maximum likelihood models.

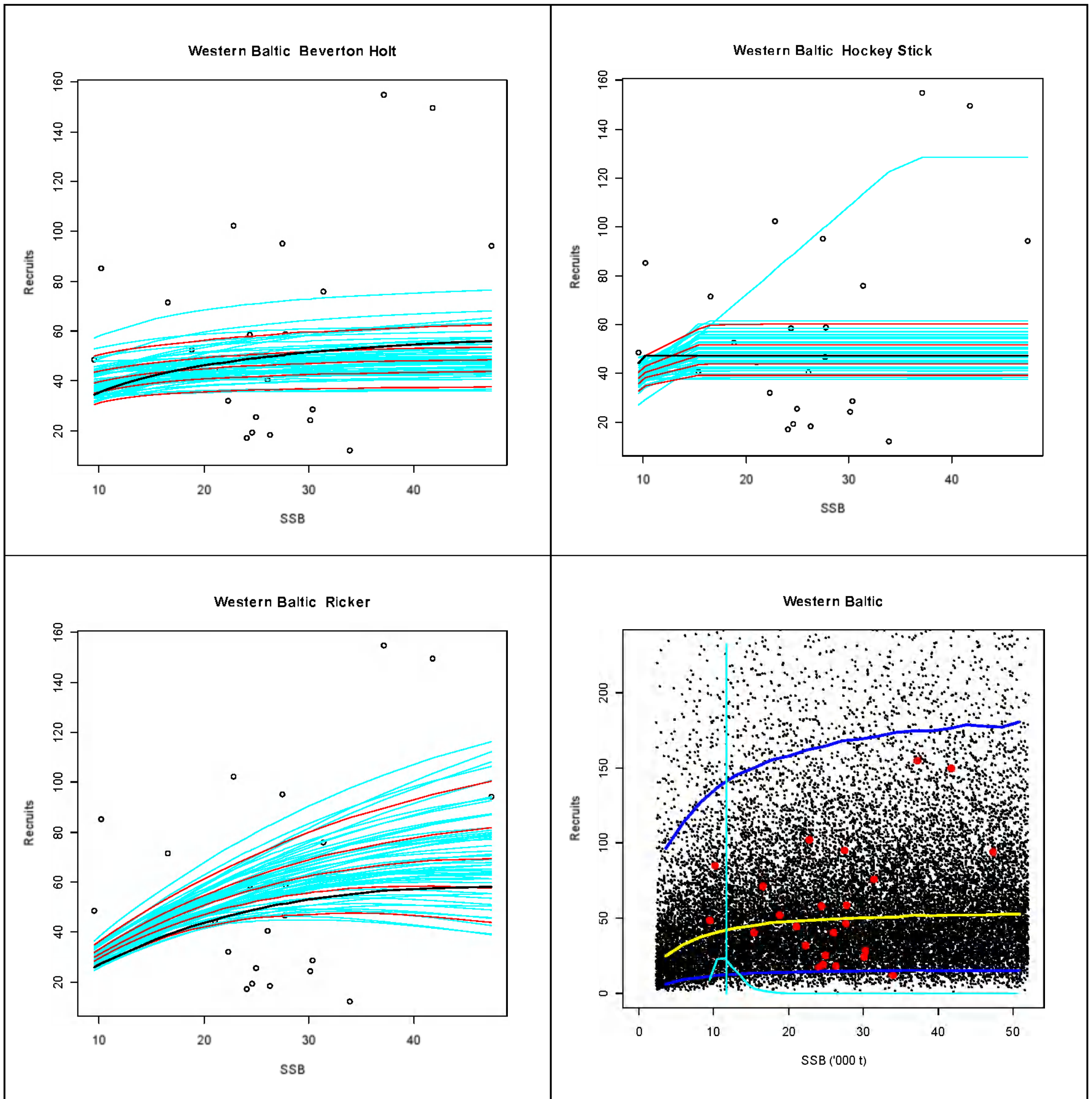

Figure 25. Western Baltic cod mid timeseries S-R models with Bayesian fits with A common across stock and period and independent B parameters and simulated values for a) Beverton Holt, b) Hockey stick and c) Ricker functional relationships individually and d) combined simulated values. Panels a,b,c) S-R observations from ICES assessments (o); 50 randomly selected models (cyan lines); Quantiles of modeled mean R at 5,25,50,75,95% (red lines). For panel d) S-R observations from ICES assessments (●); simulated values using 35, 60,5 % of BH,HS,R models (•) median (yellow) and 5,95% (blue) .Distribution of Blim from HS model and median value (Cyan)

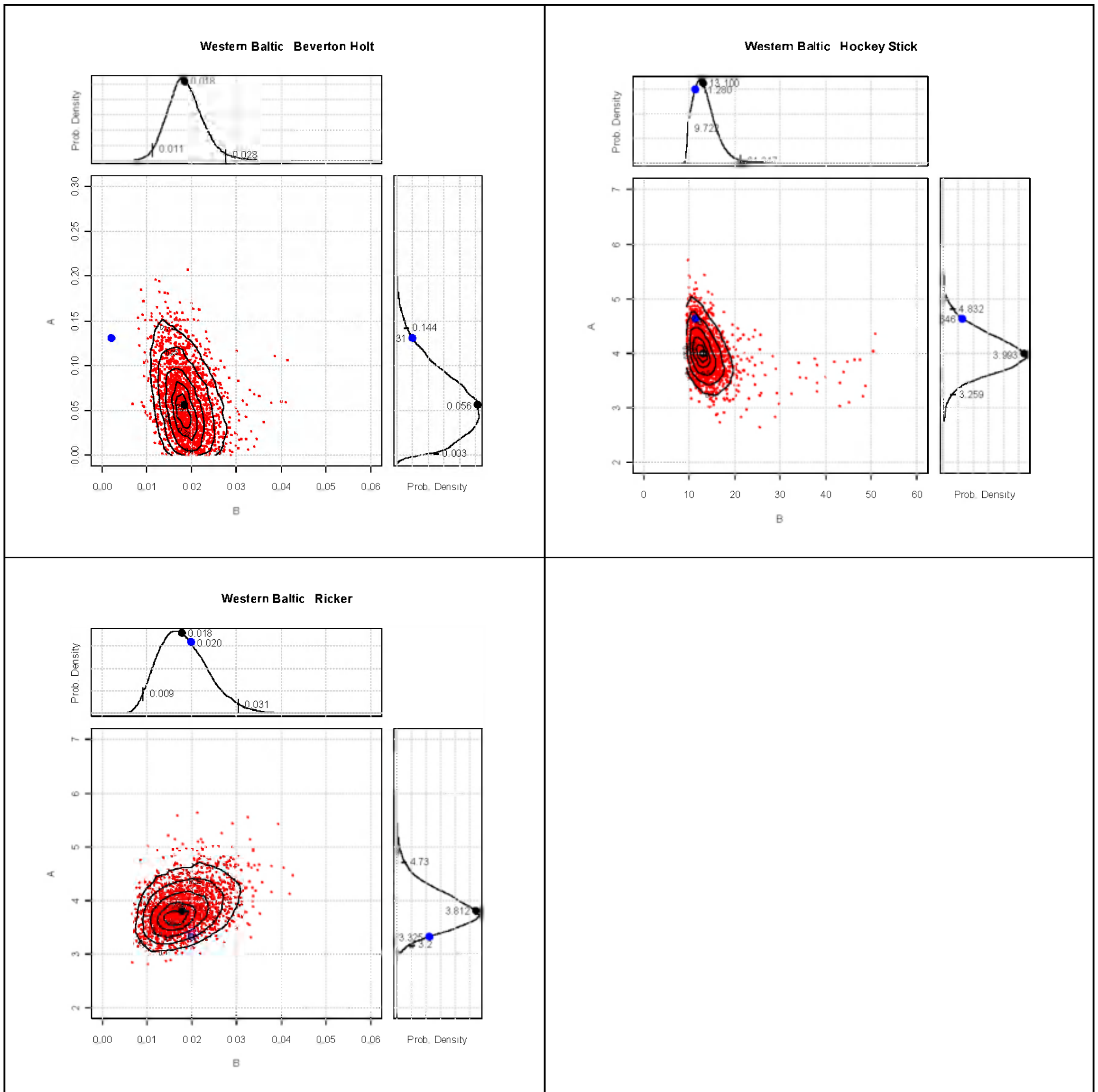

Figure 26. Western Baltic cod recent timeseries Parameter values for S-R Bayesian with A common across stock and period and independent B parameters fits for a) Beverton Holt, b) Hockey stick and c) Ricker functional relationships. Parameters A and B as defined in Table 2. black dots are median values for the fitted parameters and blue dots the parameters giving the maximum likelihood models.

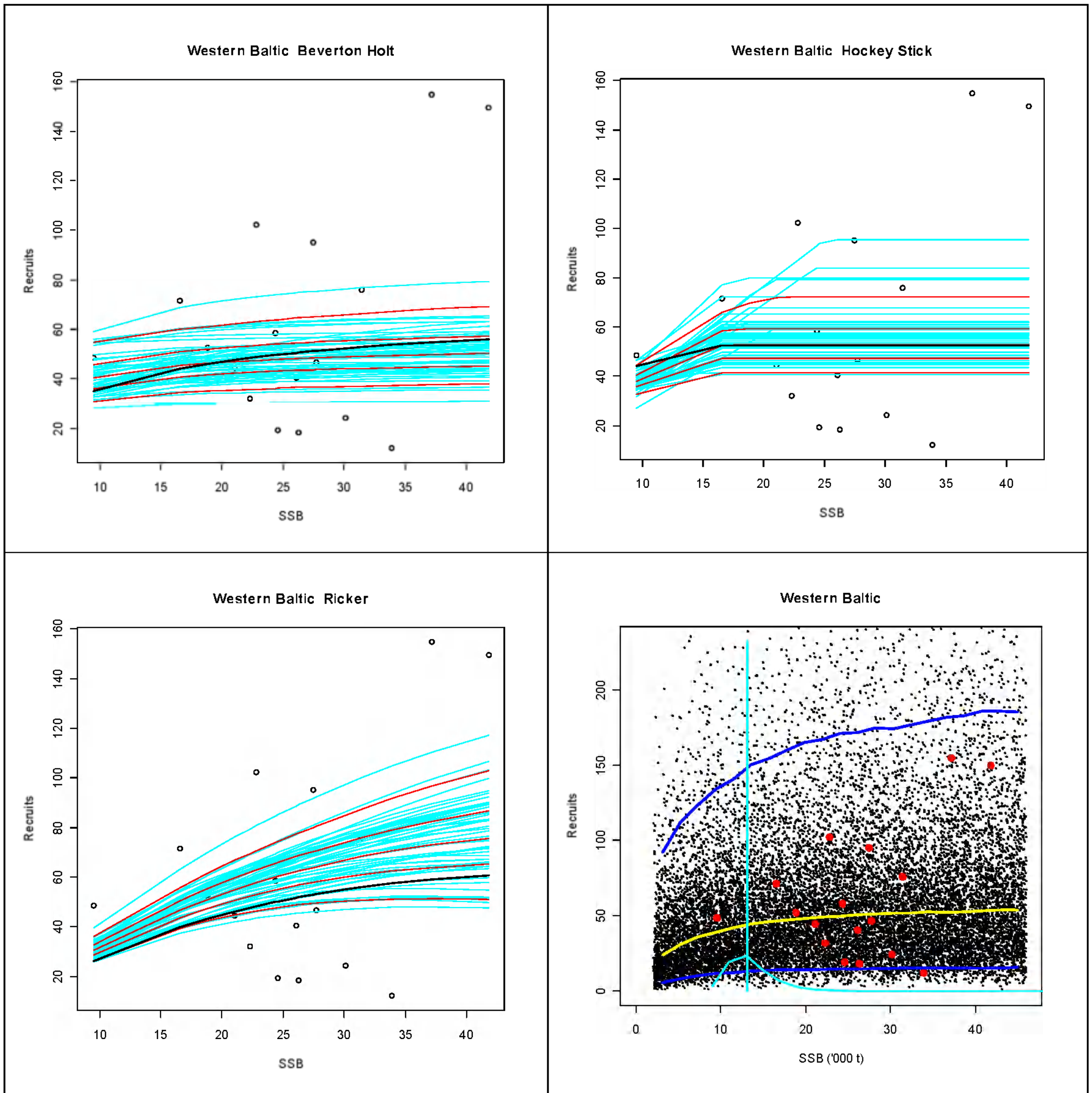

Figure 27. Western Baltic cod recent timeseries S-R models with Bayesian fits with A common across stock and period and independent B parameters and simulated values for a) Beverton Holt, b) Hockey stick and c) Ricker functional relationships individually and d) combined simulated values. Panels a,b,c) S-R observations from ICES assessments (o); 50 randomly selected models (cyan lines); Quantiles of modeled mean R at 5,25,50,75,95% (red lines). For panel d) S-R observations from ICES assessments (●); simulated values using 35, 60,5 % of BH,HS,R models (•) median (yellow) and 5,95% (blue) .Distribution of Blim from HS model and median value (Cyan)

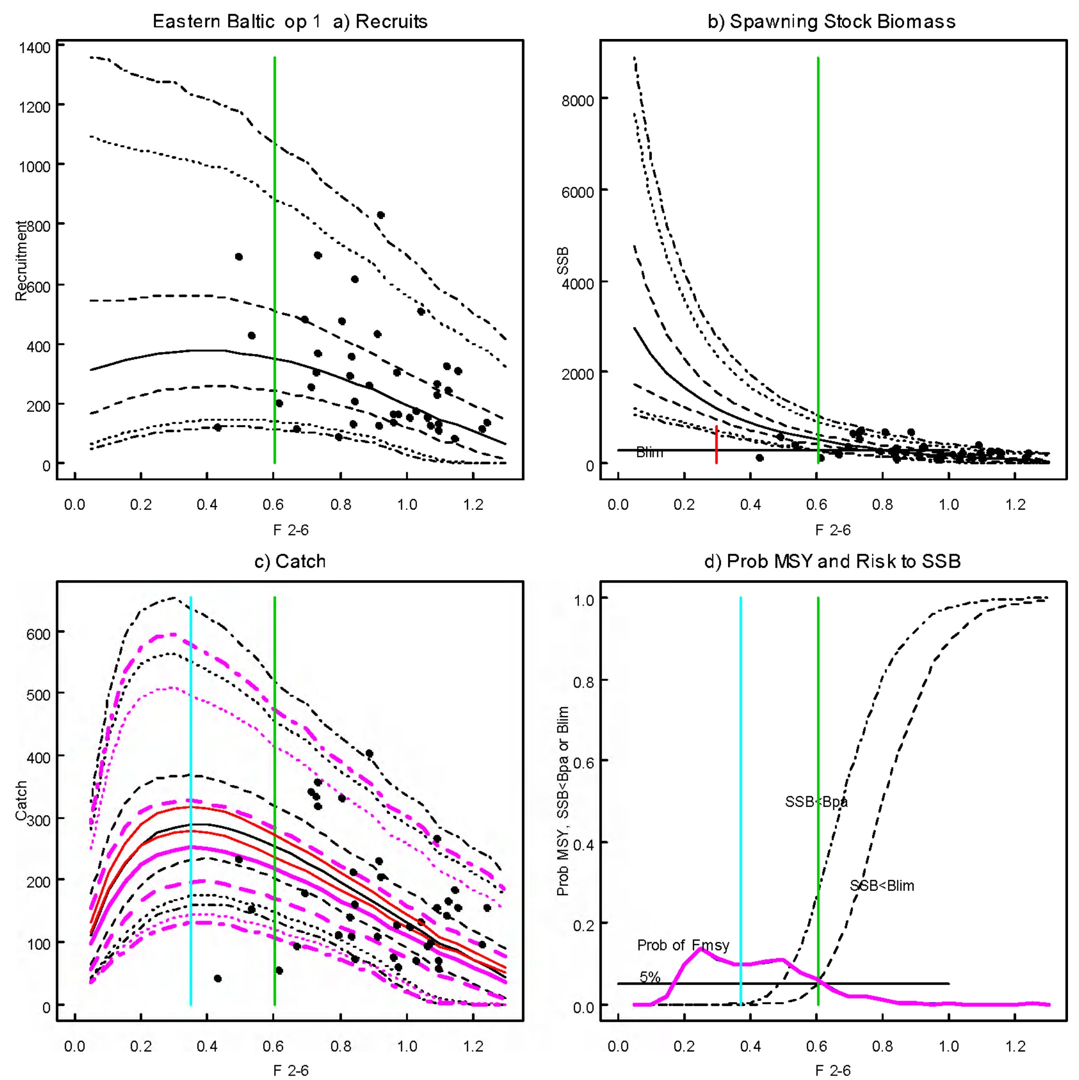

Figure 28 Equilibrium exploitation of Eastern Baltic cod (EB 1 – text table)against target F from F=0.05 to 1.3.Quantiles (0.025, 0.5, 0.25, 0.5, 0.75, 0.95, 0.975) of simulated a) Recruits, b) SSB and c) Catch: black lines and Landings pink lines. Historic Recruits, SSB and Catch: black dots. c) mean landings: red line. d) probability of SSB below Blim and Bpa: black lines and 5% probability of SSB below Blim green line in all panels. d) distribution of F for maximum landings, blue line, and maximum landings, pink line. F for maximum Landings: cyan line, based on 50% point on the distribution of F panel (d) and maximum mean Landings panel (c). The red line in panel b shows the current management plan or target F.

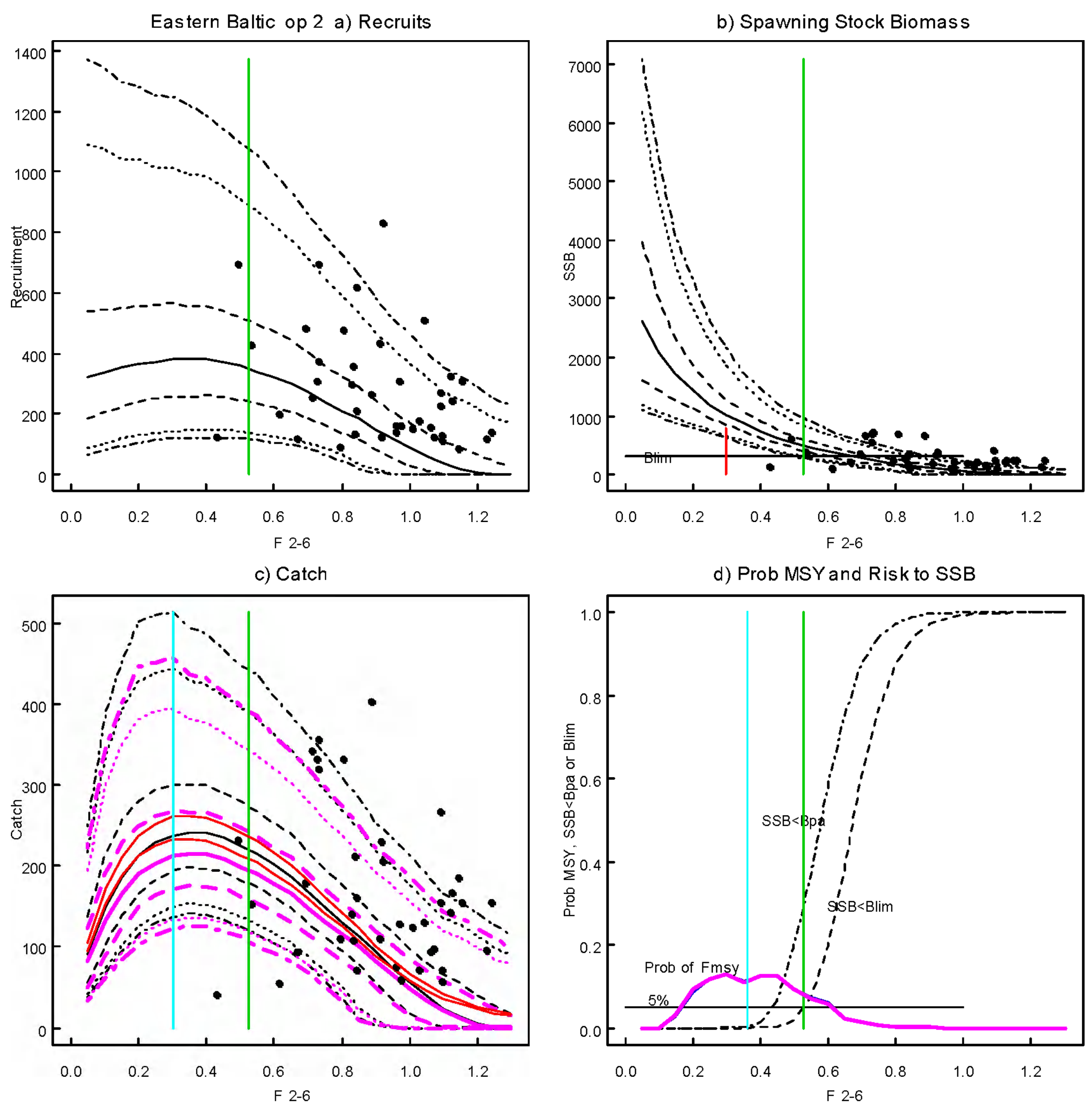

Figure 29 Equilibrium exploitation of Eastern Baltic cod (EB 2 – text table)against target F from F=0.05 to 1.3.Quantiles (0.025, 0.5, 0.25, 0.5, 0.75, 0.95, 0.975) of simulated a) Recruits, b) SSB and c) Catch: black lines and Landings pink lines. Historic Recruits, SSB and Catch: black dots. c) mean landings: red line. d) probability of SSB below Blim and Bpa: black lines and 5% probability of SSB below Blim green line in all panels. d) distribution of F for maximum landings, blue line, and maximum landings, pink line. F for maximum Landings: cyan line, based on 50% point on the distribution of F panel (d) and maximum mean Landings panel (c). The red line in panel b shows the current management plan or target F.

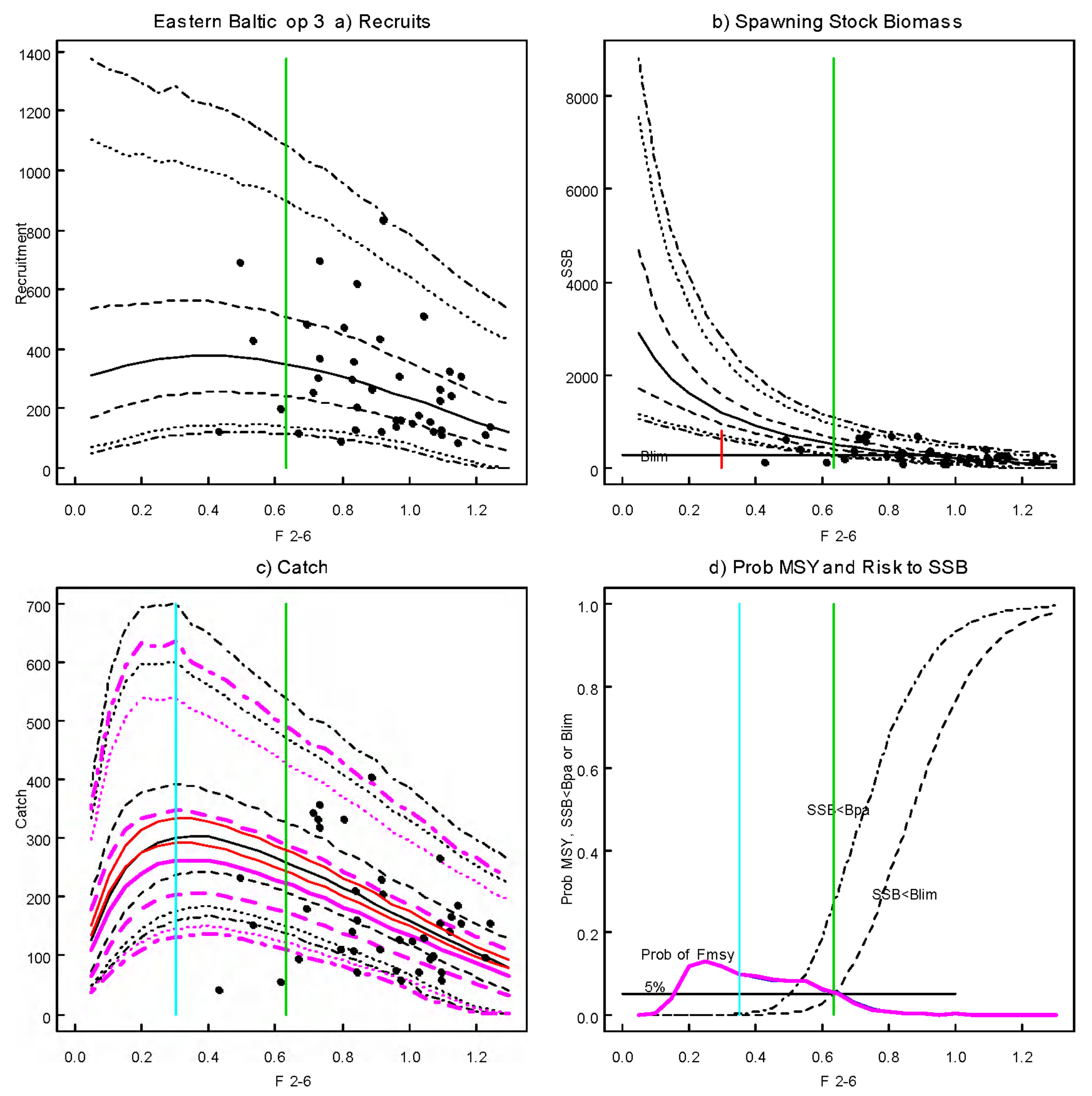

Figure 30 Equilibrium exploitation of Eastern Baltic cod (EB 3 – text table) against target F from F=0.05 to 1.3.Quantiles (0.025, 0.5, 0.25, 0.5, 0.75, 0.95, 0.975) of simulated a) Recruits, b) SSB and c) Catch: black lines and Landings pink lines. Historic Recruits, SSB and Catch: black dots. c) mean landings: red line. d) probability of SSB below Blim and Bpa: black lines and 5% probability of SSB below Blim green line in all panels. d) distribution of F for maximum landings, blue line, and maximum landings, pink line. F for maximum Landings: cyan line, based on 50% point on the distribution of F panel (d) and maximum mean Landings panel (c). The red line in panel b shows the current management plan or target F.

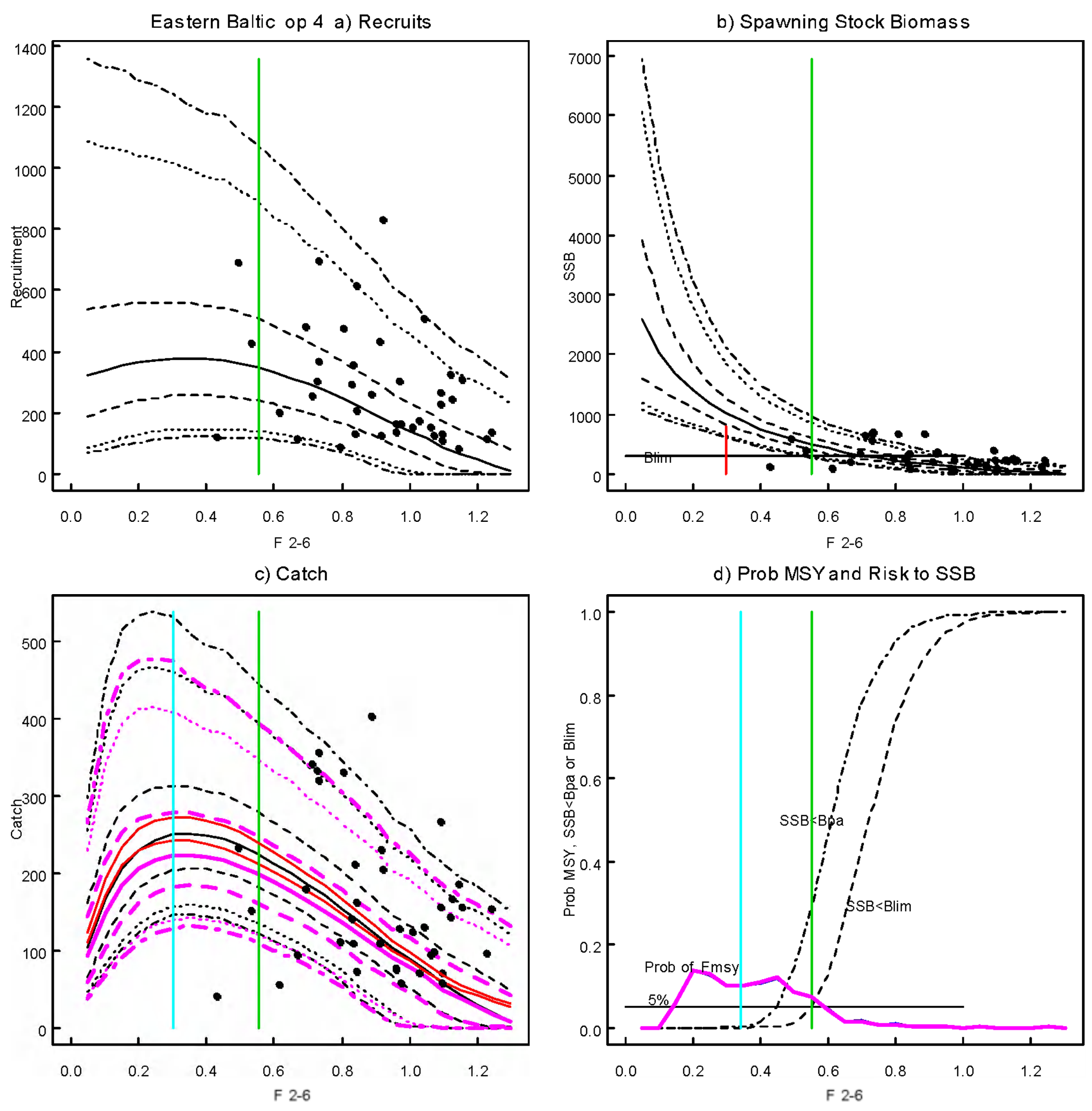

Figure 31 Equilibrium exploitation of Eastern Baltic cod (EB 4 – text table)against target F from F=0.05 to 1.3.Quantiles (0.025, 0.5, 0.25, 0.5, 0.75, 0.95, 0.975) of simulated a) Recruits, b) SSB and c) Catch: black lines and Landings pink lines. Historic Recruits, SSB and Catch: black dots. c) mean landings: red line. d) probability of SSB below Blim and Bpa: black lines and 5% probability of SSB below Blim green line in all panels. d) distribution of F for maximum landings, blue line, and maximum landings, pink line. F for maximum Landings: cyan line, based on 50% point on the distribution of F panel (d) and maximum mean Landings panel (c). The red line in panel b shows the current management plan or target F.

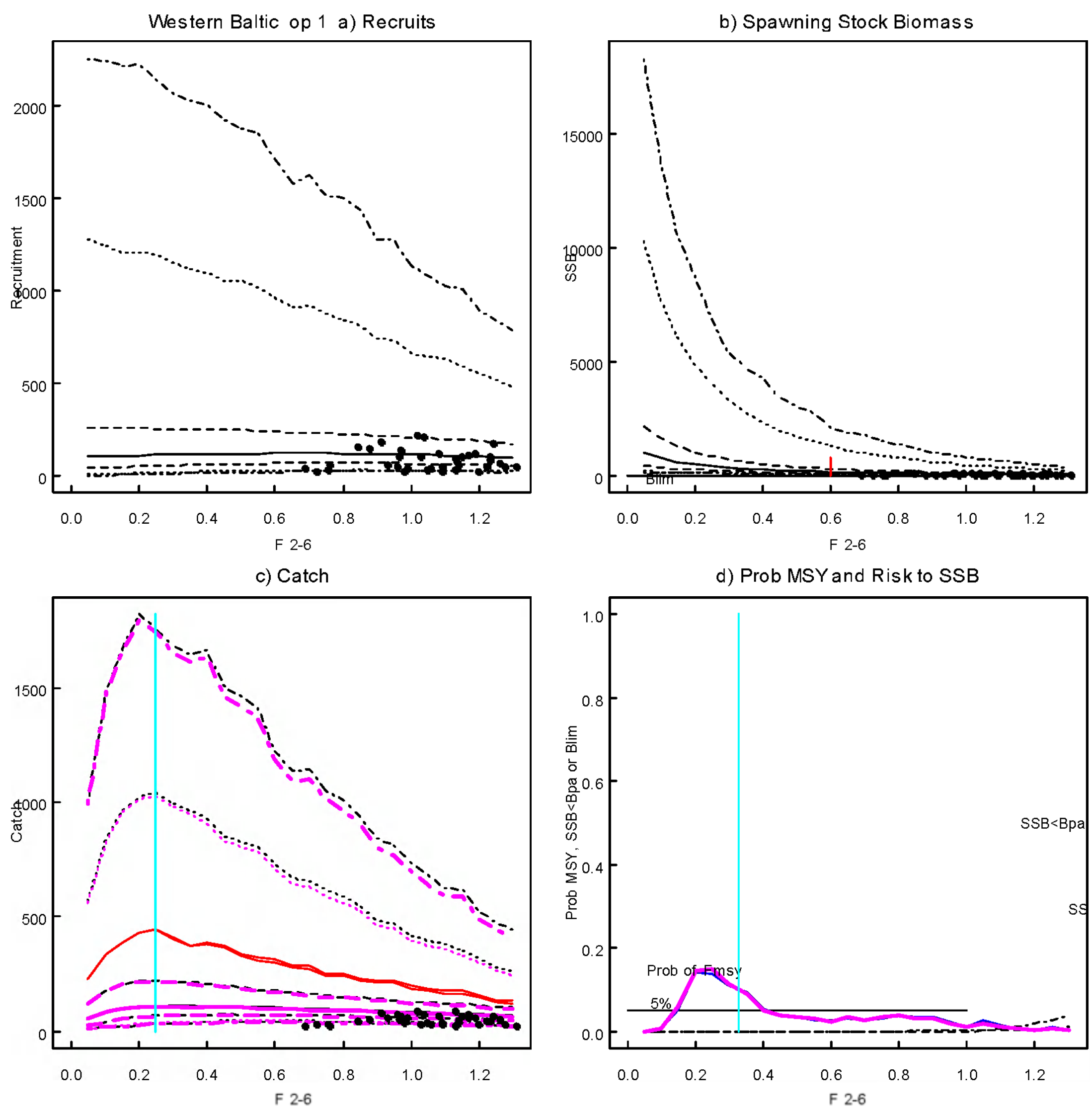

Figure 32 Equilibrium exploitation of Western Baltic cod (WB 1 – text table) against target F from F=0.05 to 1.3.Quantiles (0.025, 0.5, 0.25, 0.5, 0.75, 0.95, 0.975) of simulated a) Recruits, b) SSB and c) Catch: black lines and Landings pink lines. Historic Recruits, SSB and Catch: black dots. c) mean landings: red line. d) probability of SSB below Blim and Bpa: black lines and 5% probability of SSB below Blim green line in all panels. d) distribution of F for maximum landings, blue line, and maximum landings, pink line. F for maximum Landings: cyan line, based on 50% point on the distribution of F panel (d) and maximum mean Landings panel (c). The red line in panel b shows the current management plan or target F.

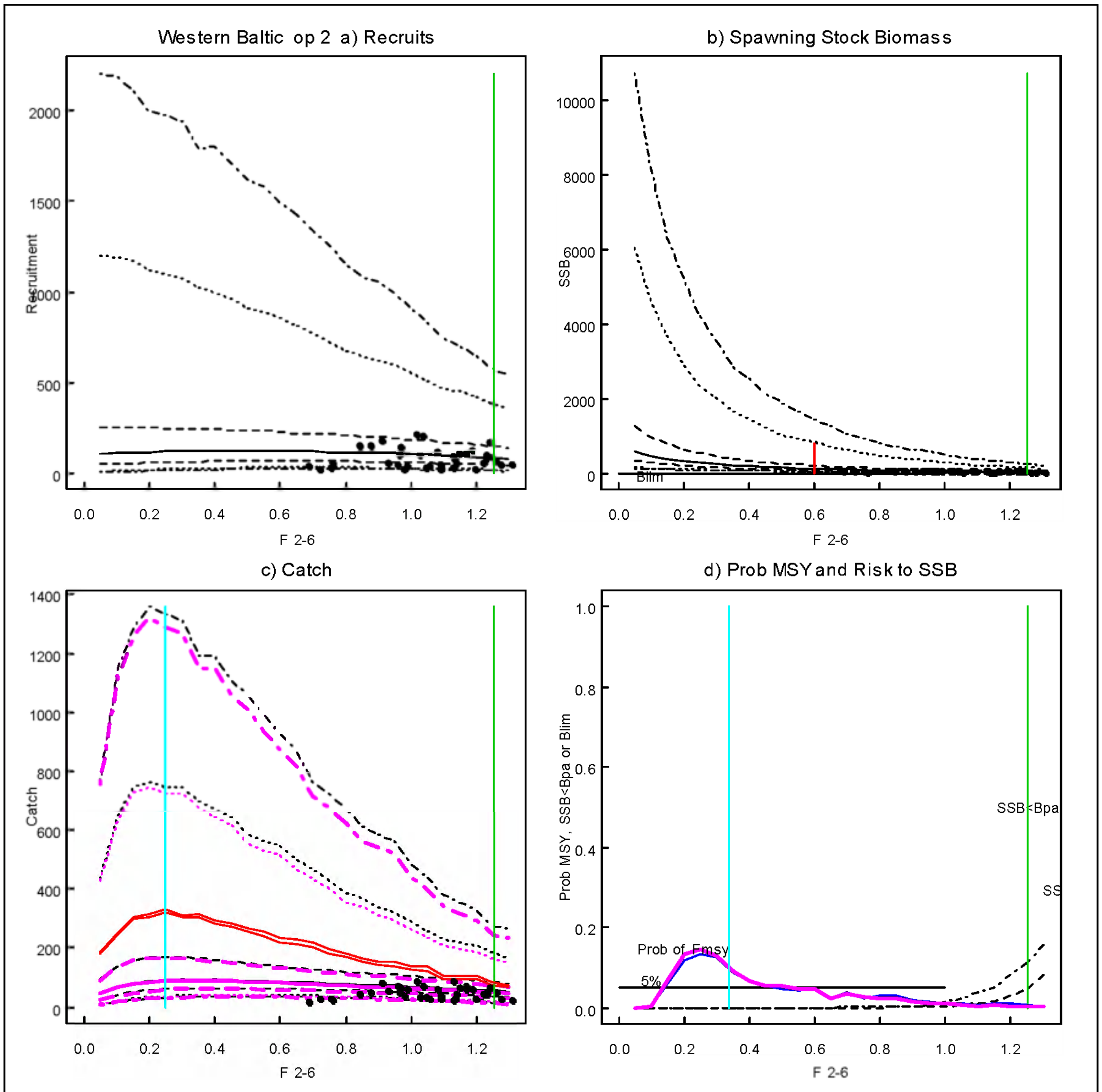

Figure 33 Equilibrium exploitation of Western Baltic cod (WB 2 – text table) against target F from F=0.05 to 1.3.Quantiles (0.025, 0.5, 0.25, 0.5, 0.75, 0.95, 0.975) of simulated a) Recruits, b) SSB and c) Catch: black lines and Landings pink lines. Historic Recruits, SSB and Catch: black dots. c) mean landings: red line. d) probability of SSB below Blim and Bpa: black lines and 5% probability of SSB below Blim green line in all panels. d) distribution of F for maximum landings, blue line, and maximum landings, pink line. F for maximum Landings: cyan line, based on 50% point on the distribution of F panel (d) and maximum mean Landings panel (c). The red line in panel b shows the current management plan or target F.

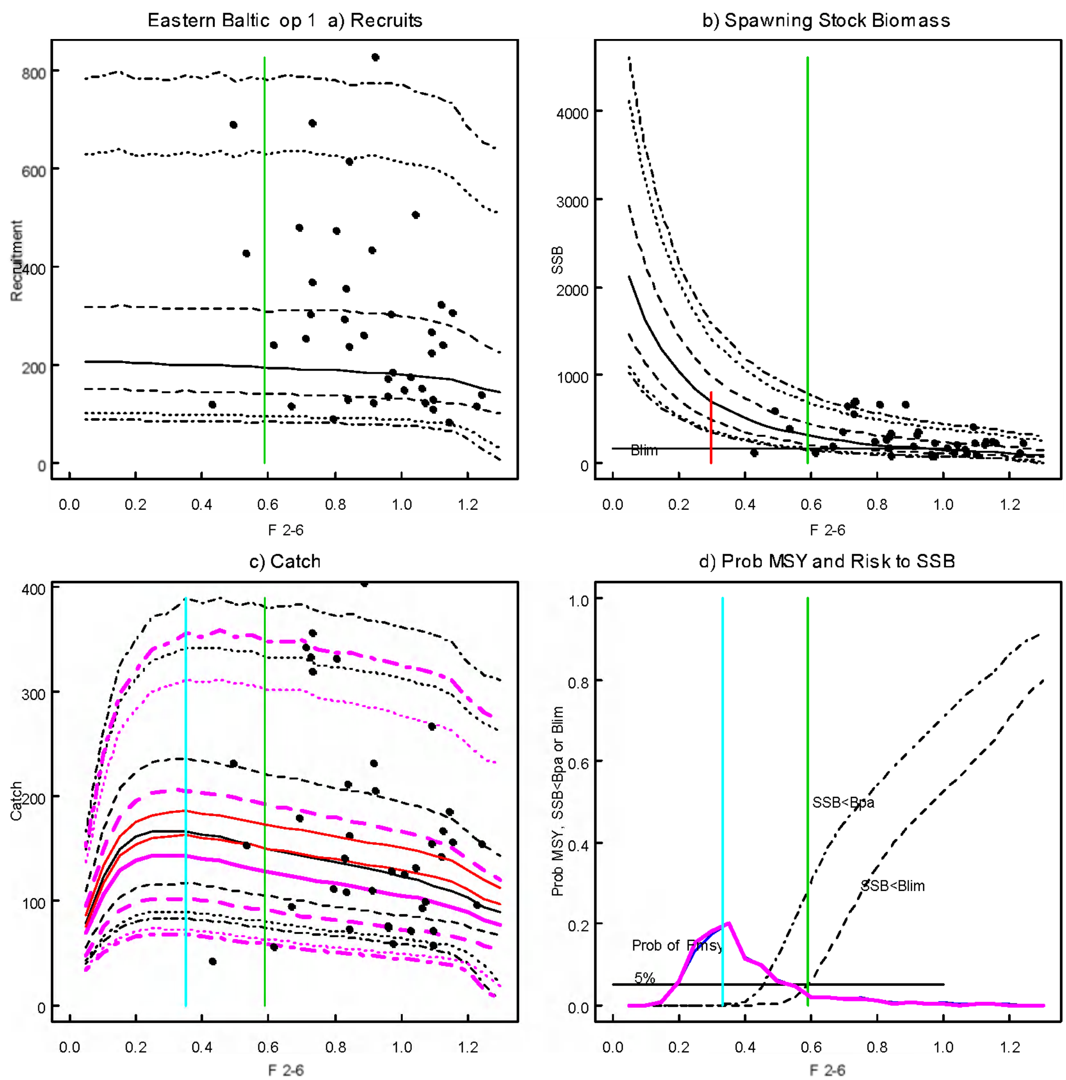

Figure 34 Equilibrium exploitation of Eastern Baltic cod (EB 1 – text table)against target F from F=0.05 to 1.3.Quantiles (0.025, 0.5, 0.25, 0.5, 0.75, 0.95, 0.975) of simulated a) Recruits, b) SSB and c) Catch: black lines and Landings pink lines. Historic Recruits, SSB and Catch: black dots. c) mean landings: red line. d) probability of SSB below Blim and Bpa: black lines and 5% probability of SSB below Blim green line in all panels. d) distribution of F for maximum landings, blue line, and maximum landings, pink line. F for maximum Landings: cyan line, based on 50% point on the distribution of F panel (d) and maximum mean Landings panel (c). The red line in panel b shows the current management plan or target F.

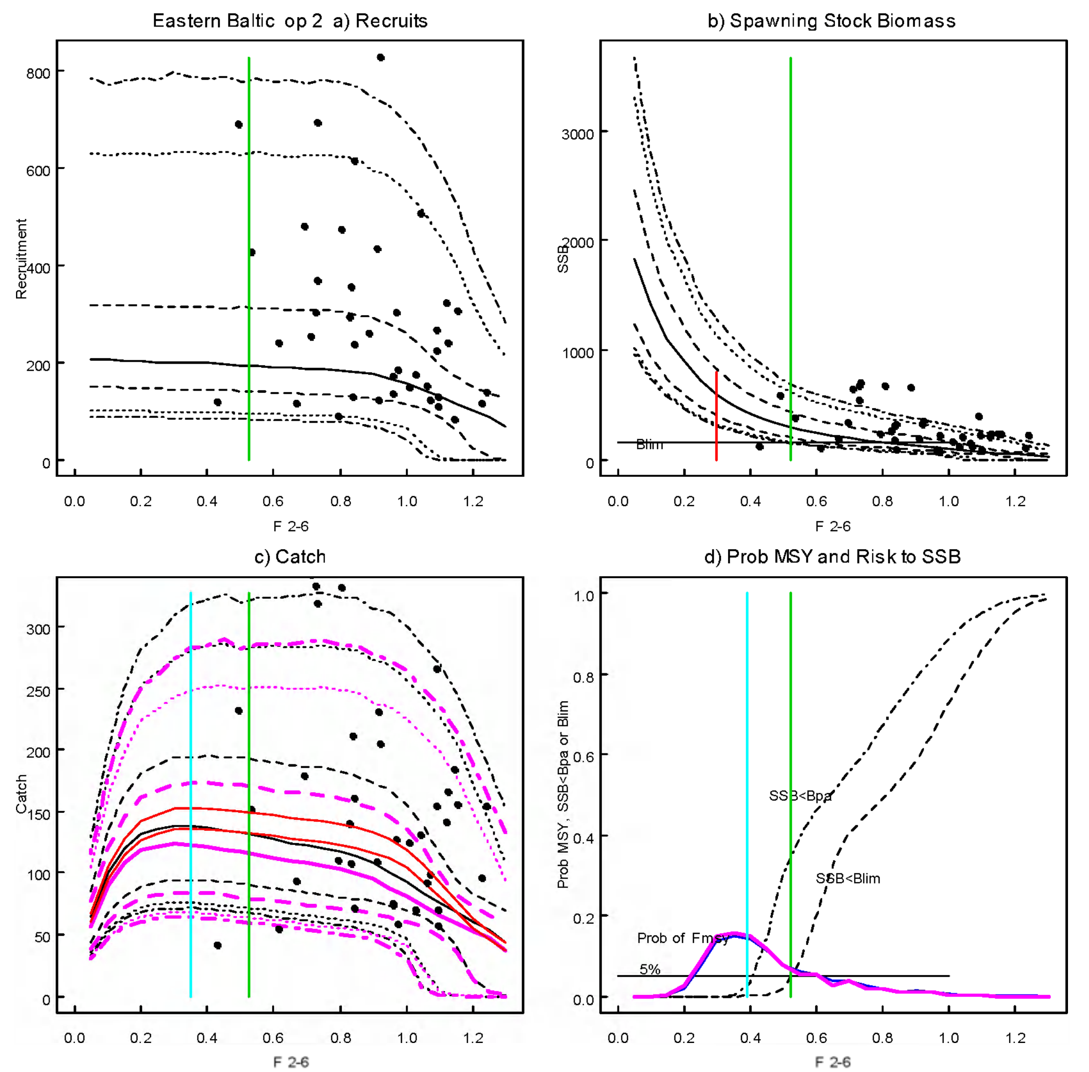

Figure 35 Equilibrium exploitation of Eastern Baltic cod (EB 2 – text table)against target F from F=0.05 to 1.3.Quantiles (0.025, 0.5, 0.25, 0.5, 0.75, 0.95, 0.975) of simulated a) Recruits, b) SSB and c) Catch: black lines and Landings pink lines. Historic Recruits, SSB and Catch: black dots. c) mean landings: red line. d) probability of SSB below Blim and Bpa: black lines and 5% probability of SSB below Blim green line in all panels. d) distribution of F for maximum landings, blue line, and maximum landings, pink line. F for maximum Landings: cyan line, based on 50% point on the distribution of F panel (d) and maximum mean Landings panel (c). The red line in panel b shows the current management plan or target F.

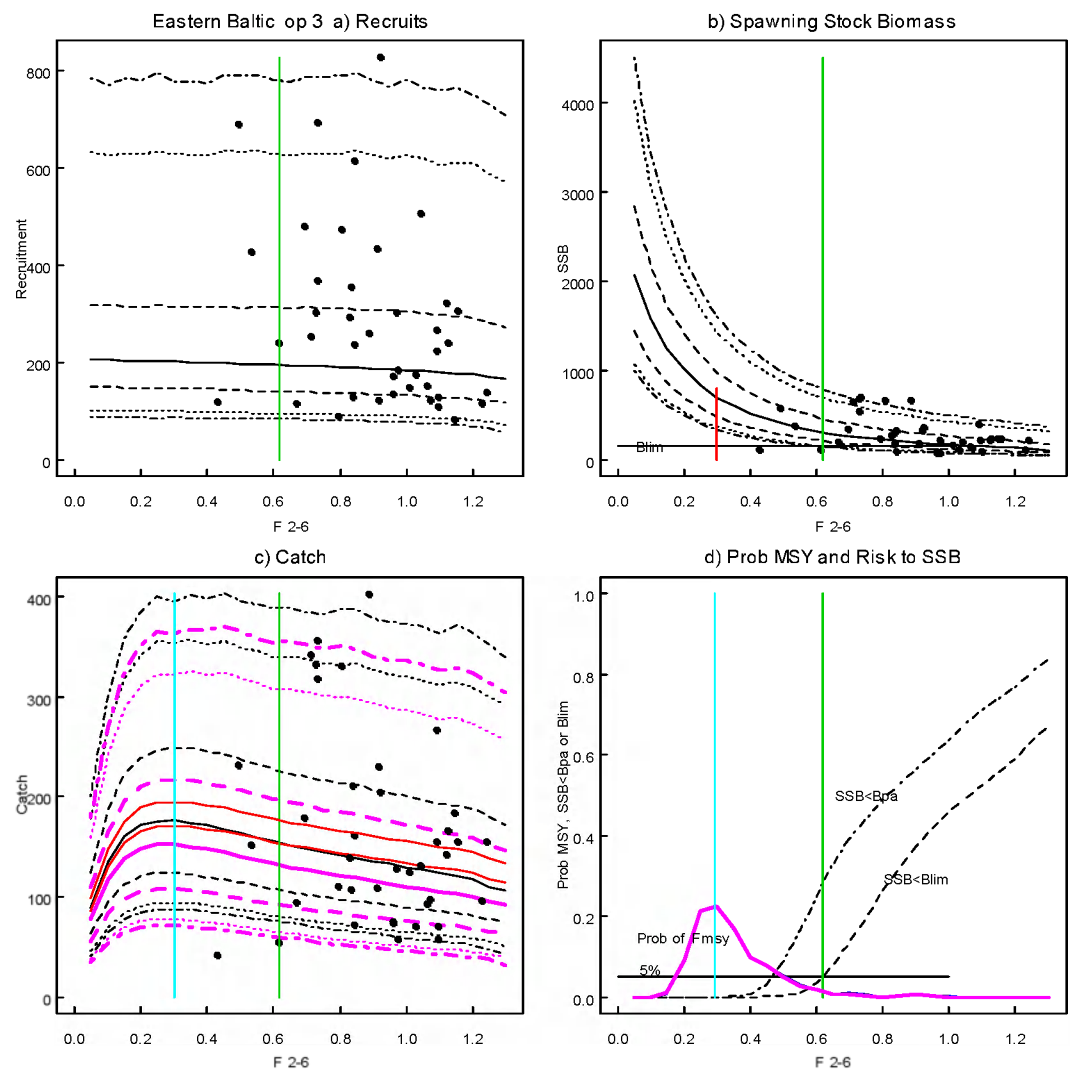

Figure 36 Equilibrium exploitation of Eastern Baltic cod (EB 3 – text table) against target F from F=0.05 to 1.3.Quantiles (0.025, 0.5, 0.25, 0.5, 0.75, 0.95, 0.975) of simulated a) Recruits, b) SSB and c) Catch: black lines and Landings pink lines. Historic Recruits, SSB and Catch: black dots. c) mean landings: red line. d) probability of SSB below Blim and Bpa: black lines and 5% probability of SSB below Blim green line in all panels. d) distribution of F for maximum landings, blue line, and maximum landings, pink line. F for maximum Landings: cyan line, based on 50% point on the distribution of F panel (d) and maximum mean Landings panel (c). The red line in panel b shows the current management plan or target F.

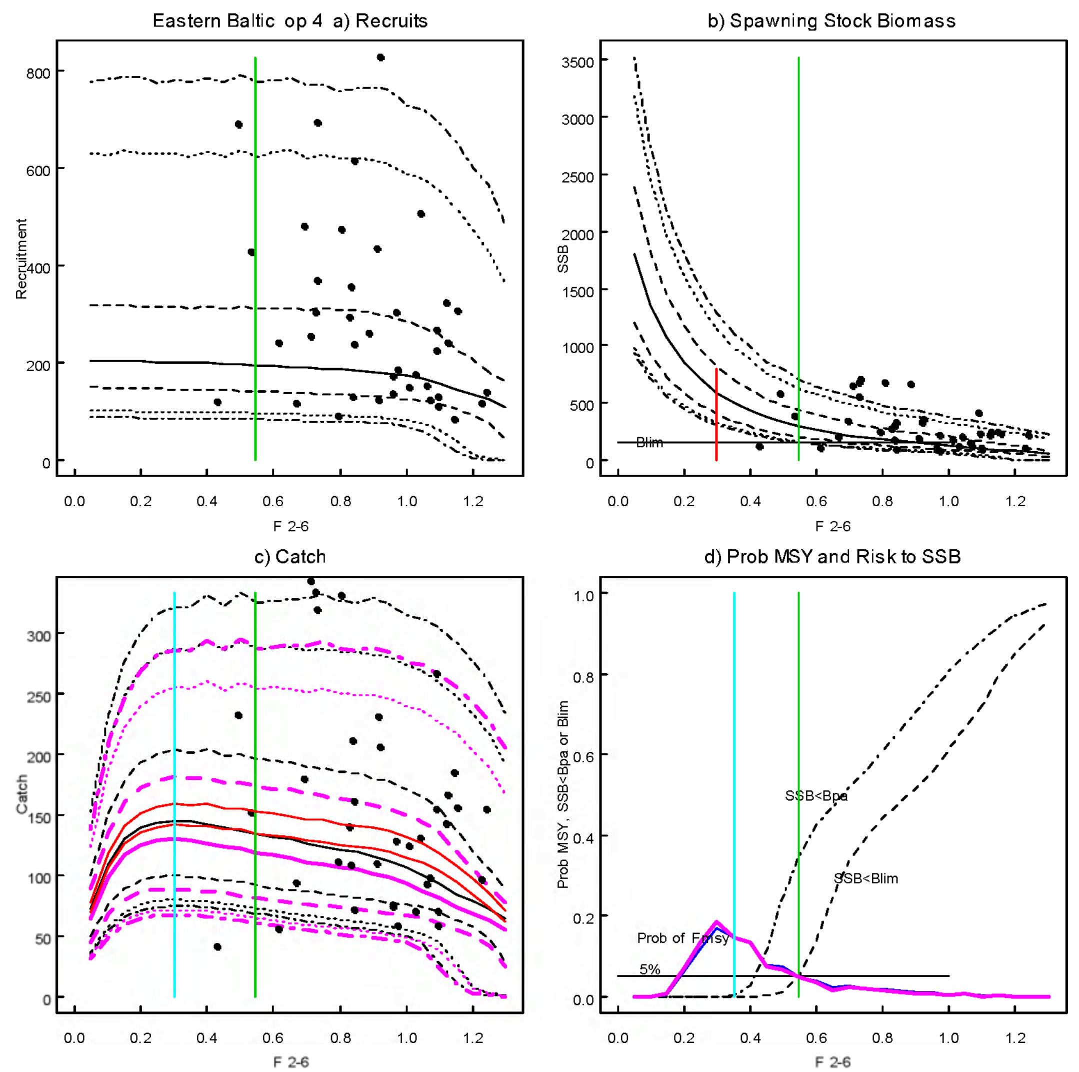

Figure 37 Equilibrium exploitation of Eastern Baltic cod (EB 4 – text table)against target F from F=0.05 to 1.3.Quantiles (0.025, 0.5, 0.25, 0.5, 0.75, 0.95, 0.975) of simulated a) Recruits, b) SSB and c) Catch: black lines and Landings pink lines. Historic Recruits, SSB and Catch: black dots. c) mean landings: red line. d) probability of SSB below Blim and Bpa: black lines and 5% probability of SSB below Blim green line in all panels. d) distribution of F for maximum landings, blue line, and maximum landings, pink line. F for maximum Landings: cyan line, based on 50% point on the distribution of F panel (d) and maximum mean Landings panel (c). The red line in panel b shows the current management plan or target F.

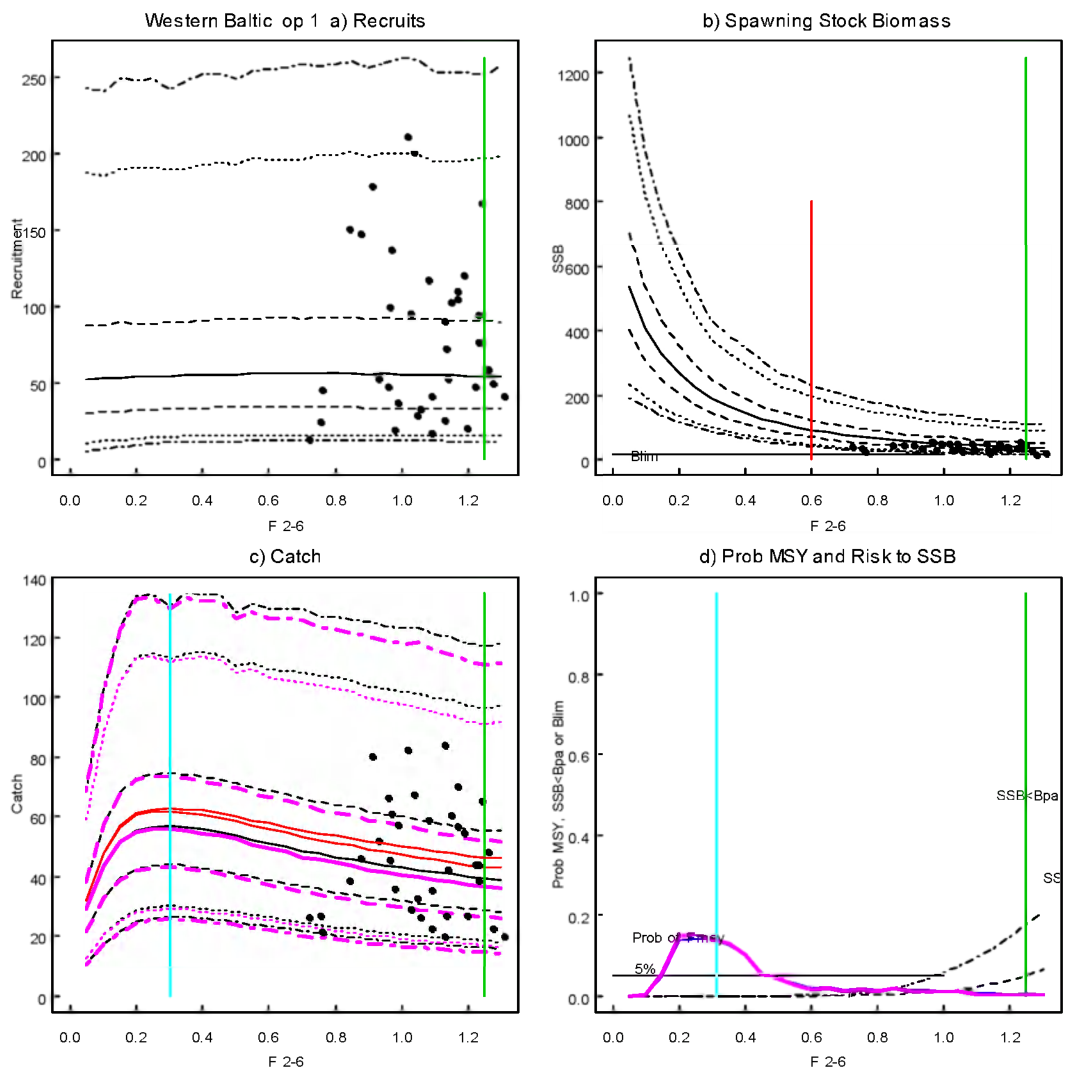

Figure 38 Equilibrium exploitation of Western Baltic cod (WB 1 – text table) against target F from F=0.05 to 1.3.Quantiles (0.025, 0.5, 0.25, 0.5, 0.75, 0.95, 0.975) of simulated a) Recruits, b) SSB and c) Catch: black lines and Landings pink lines. Historic Recruits, SSB and Catch: black dots. c) mean landings: red line. d) probability of SSB below Blim and Bpa: black lines and 5% probability of SSB below Blim green line in all panels. d) distribution of F for maximum landings, blue line, and maximum landings, pink line. F for maximum Landings: cyan line, based on 50% point on the distribution of F panel (d) and maximum mean Landings panel (c). The red line in panel b shows the current management plan or target F.

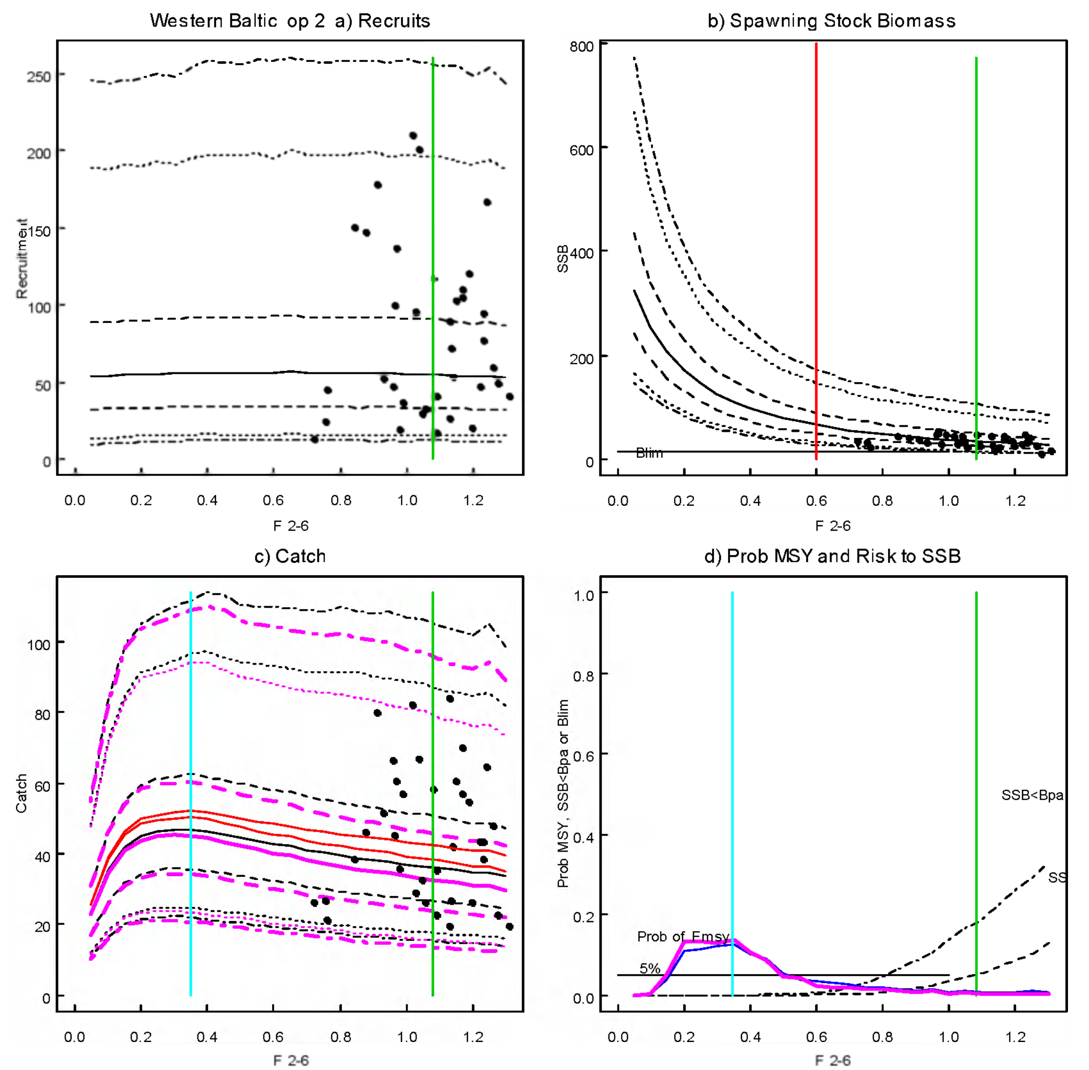

Figure 39 Equilibrium exploitation of Western Baltic cod (WB 2 – text table) against target F from F=0.05 to 1.3.Quantiles (0.025, 0.5, 0.25, 0.5, 0.75, 0.95, 0.975) of simulated a) Recruits, b) SSB and c) Catch: black lines and Landings pink lines. Historic Recruits, SSB and Catch: black dots. c) mean landings: red line. d) probability of SSB below Blim and Bpa: black lines and 5% probability of SSB below Blim green line in all panels. d) distribution of F for maximum landings, blue line, and maximum landings, pink line. F for maximum Landings: cyan line, based on 50% point on the distribution of F panel (d) and maximum mean Landings panel (c). The red line in panel b shows the current management plan or target F.

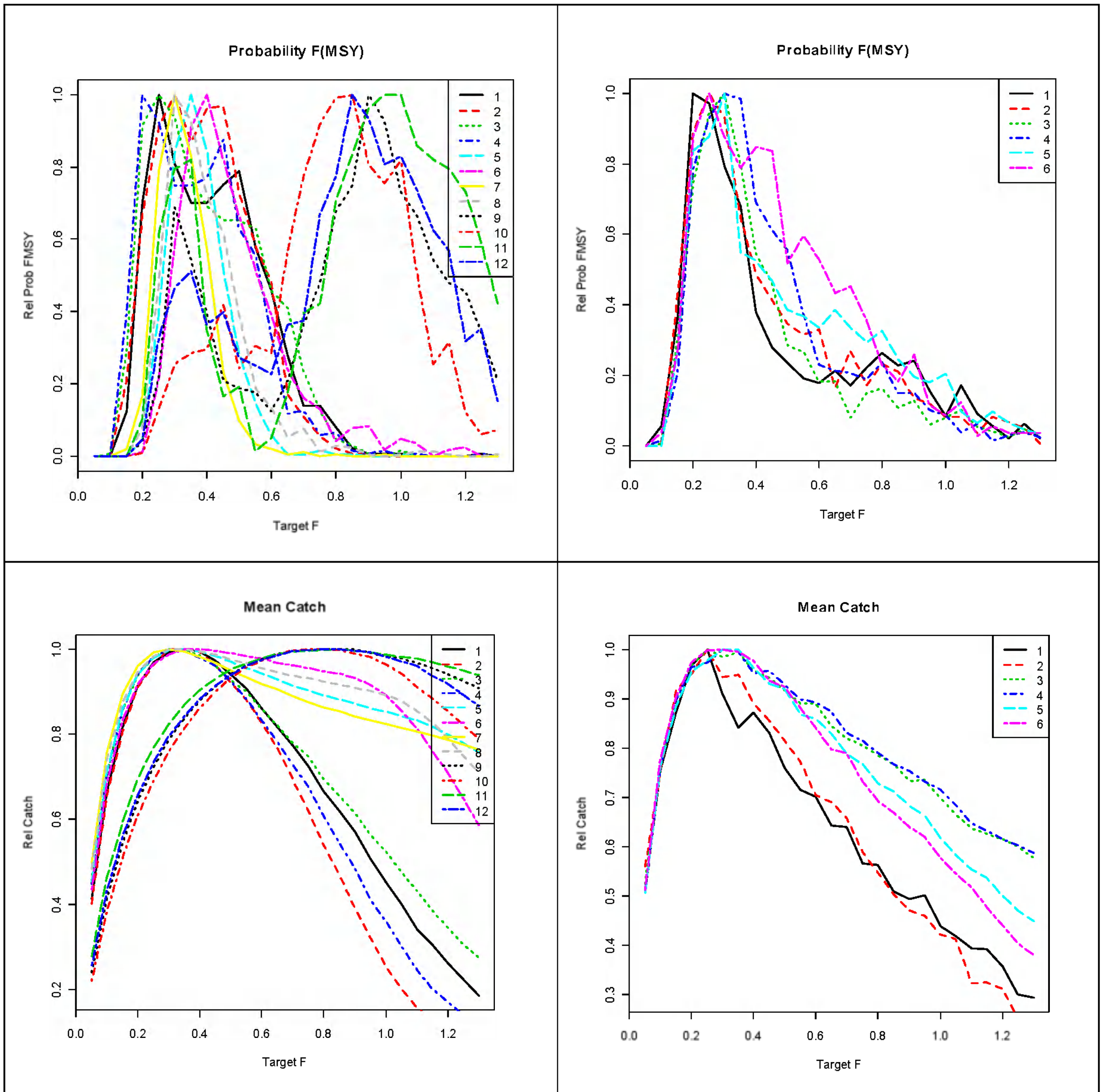

Figure 40 Equilibrium exploitation of Eastern and Western Baltic cod. Distribution of population Fmsy values by S-R selection weight and maturity group. Assuming recruitment resilience (A parameter on S-R function) is different across stocks and data periods.

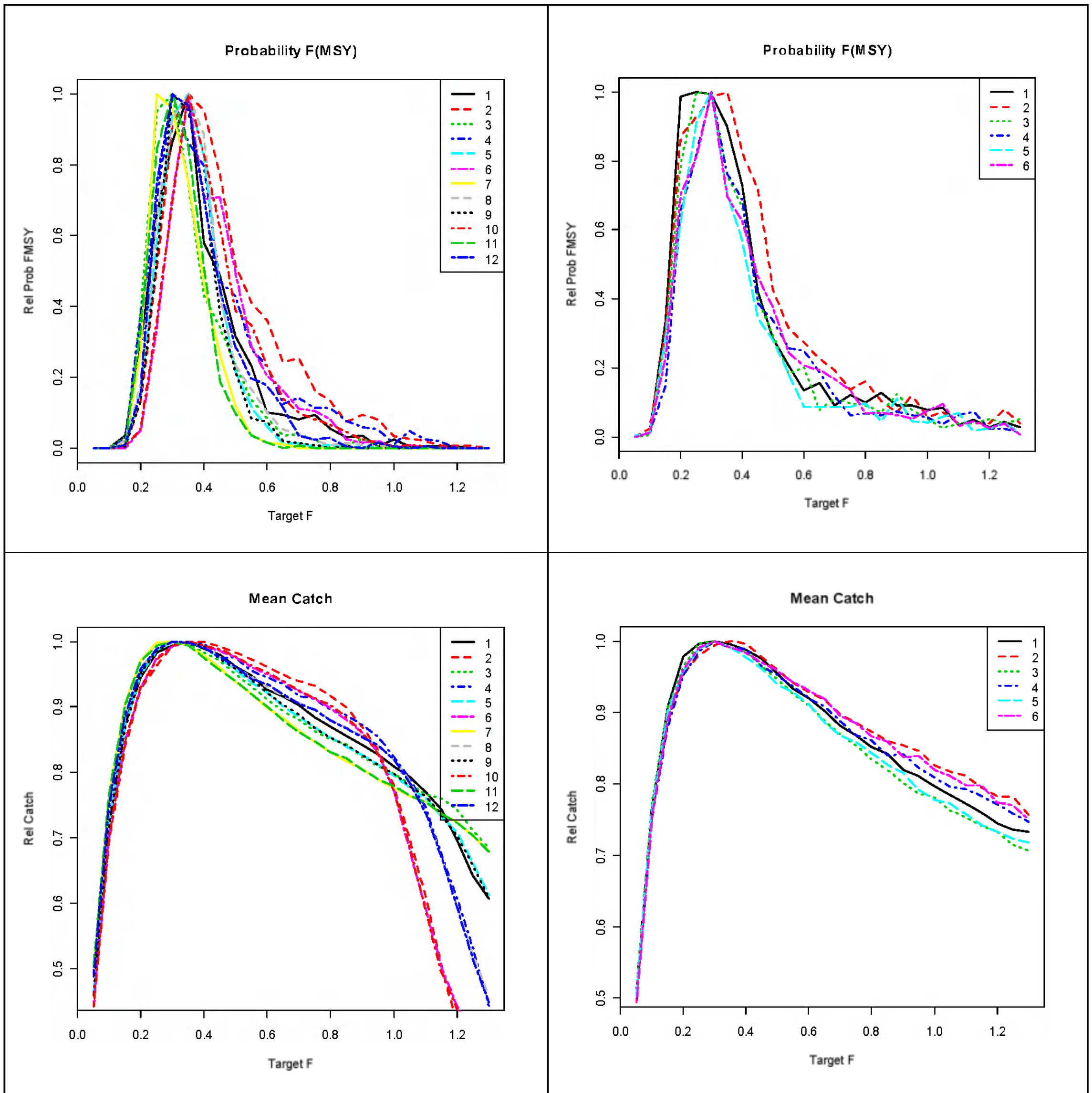

Figure 41 Equilibrium exploitation of Eastern and Western Baltic cod. Distribution of population Fmsy values by S-R selection weight and maturity group. Assuming recruitment resilience (A parameter on S-R function) is common across stocks and data periods.

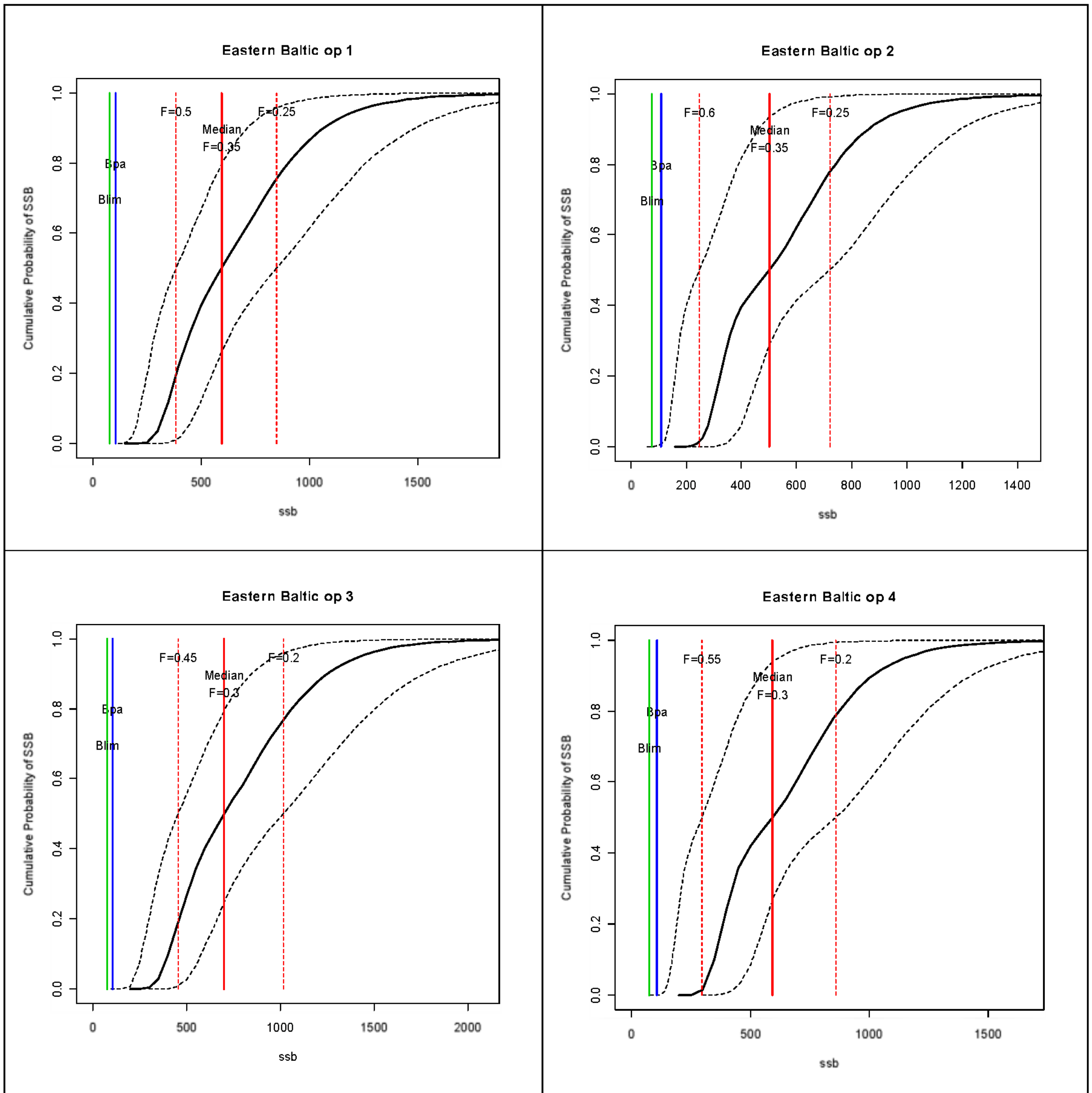

Figure 42 Eastern Baltic cod options 9-12 (see Table 1) Equilibrium exploitation without measurement or implementation error. Distribution of SSB at fixed F equilibrium exploitation for maximum mean landings and at F that gives 95% of maximum mean landings, with estimated ICES Blim and Bpa=1.4*Blim

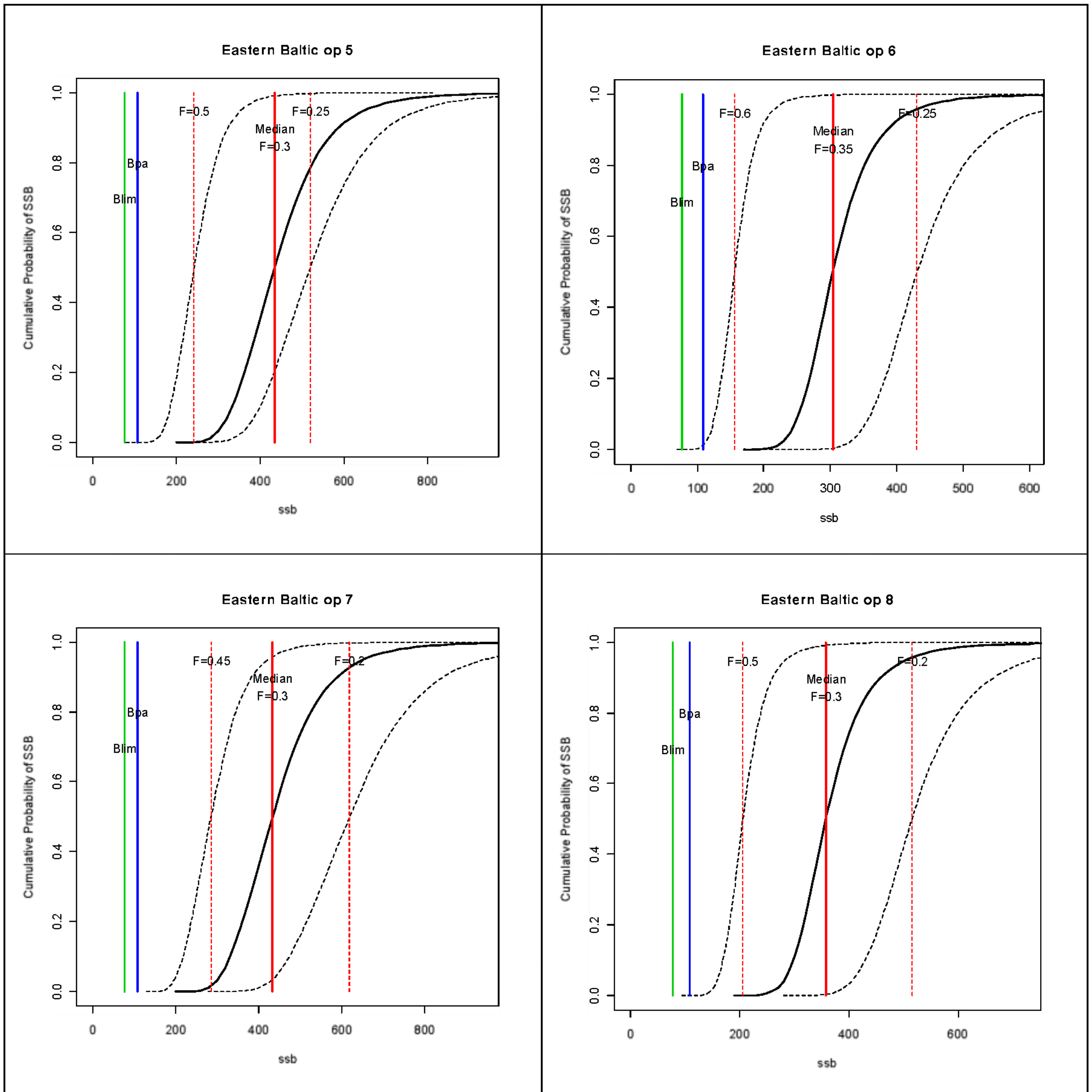

Figure 43 Eastern Baltic cod options 9-12 (see Table 1) Equilibrium exploitation without measurement or implementation error. Distribution of SSB at fixed F equilibrium exploitation for maximum mean landings and at F that gives 95% of maximum mean landings, with estimated ICES Blim and Bpa=1.4*Blim

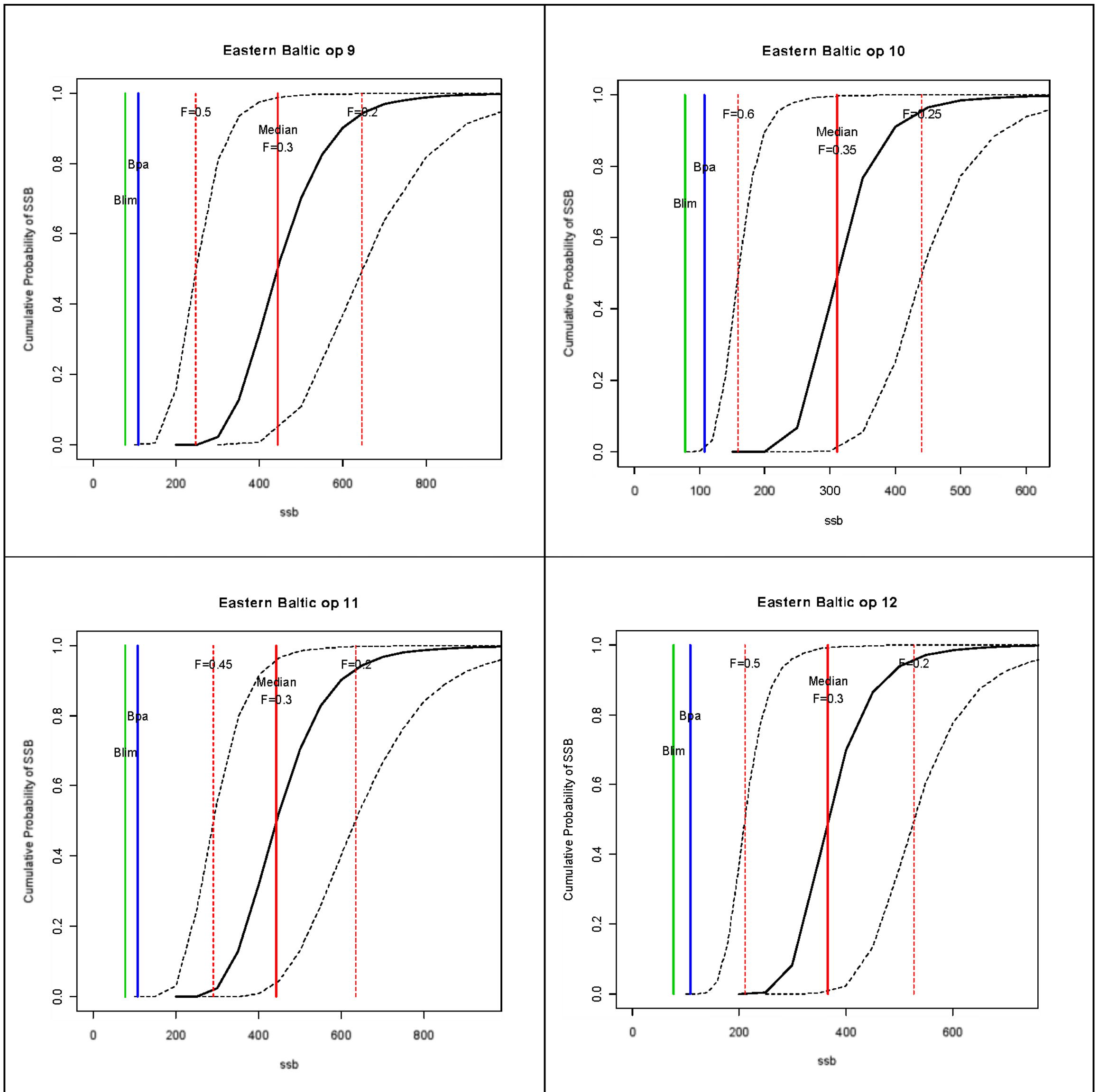

Figure 44 Eastern Baltic cod options 9-12 (see Table 1) Equilibrium exploitation without measurement or implementation error. Distribution of SSB at fixed F equilibrium exploitation for maximum mean landings and at F that gives 95% of maximum mean landings, with estimated ICES Blim and Bpa=1.4*Blim

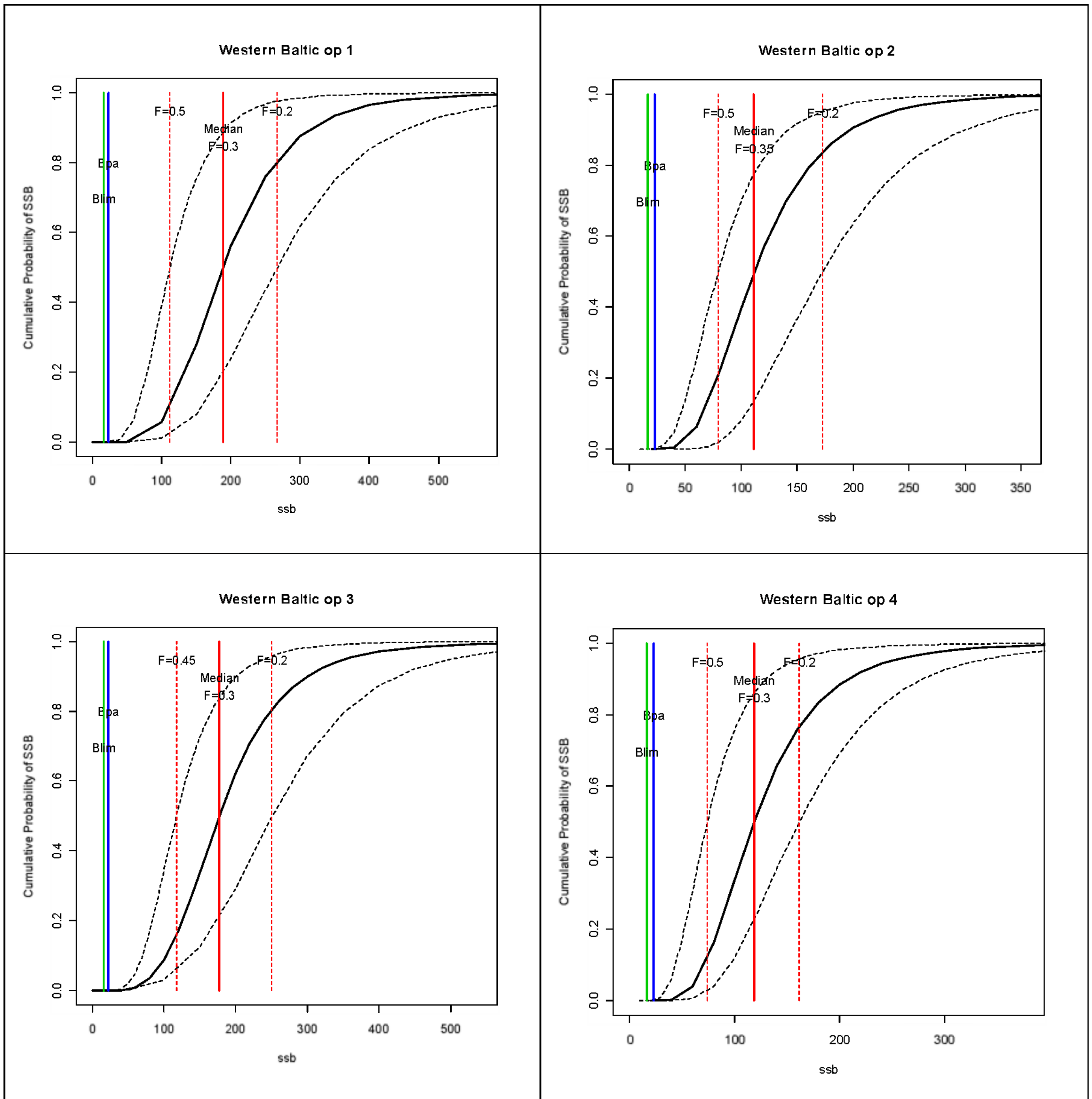

Figure 45 Western Baltic cod options 1-4 (see Table 1) Equilibrium exploitation without measurement or implementation error. Distribution of SSB at fixed F equilibrium exploitation for maximum mean landings and at F that gives 95% of maximum mean landings, with estimated ICES Bpa. and Blim=Bp/1.4

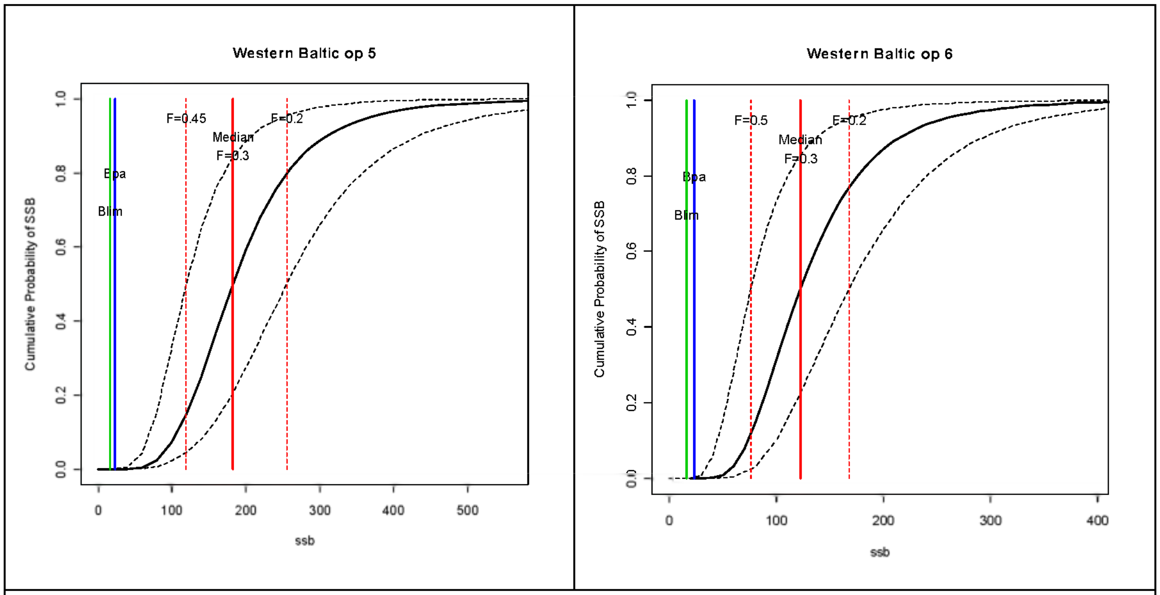

Figure 46 Western Baltic cod options 5 & 6 (see Table 1) Equilibrium exploitation without measurement or implementation error. Distribution of SSB at fixed F equilibrium exploitation for maximum mean landings and at F that gives 95% of maximum mean landings, with estimated ICES Bpa. and Blim=Bp/1.4

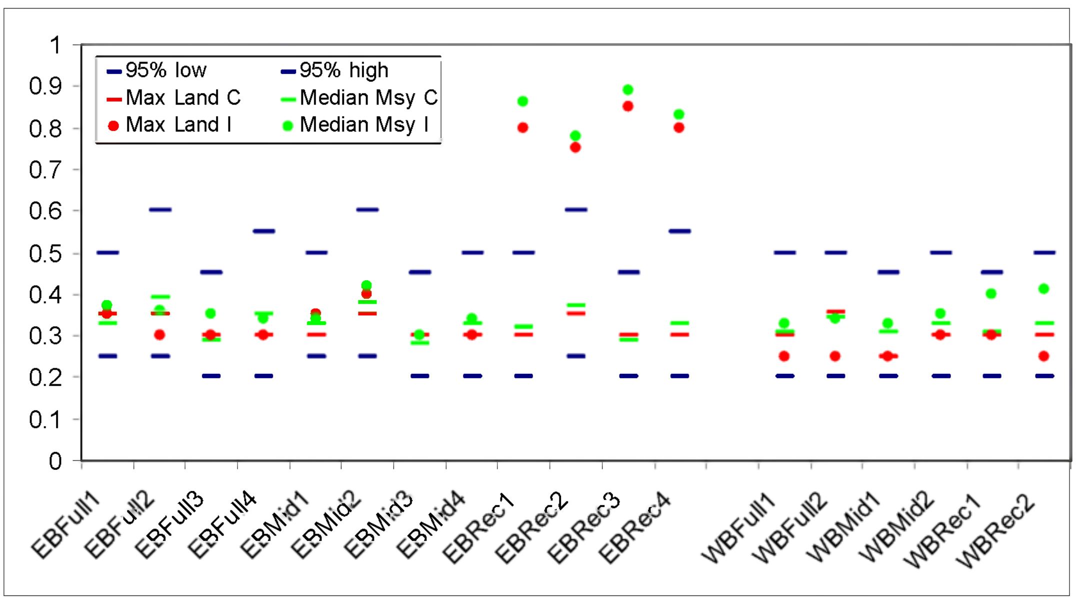

Figure 47 Summary of fixed F exploitation estimates of Fmsy from equilibrium exploitation of Eastern and Western Baltic cod. For twelve options for Eastern population and 6 options for Western population (see Table 1). Estimated Interval on F for exploitation >95% of Fmsy (▬). Point estimate of Fmsy based on maximum landings (▬) point estimate of Fmsy based on median population Fmsy(▬). Assuming recruitment resilience (A parameter on S-R function) is common across stocks and data periods. Point estimate of Fmsy based on maximum landings (●) point estimate of Fmsy based on median population Fmsy(●)Assuming recruitment resilience (A parameter on S-R function) is differs across stocks data periods.

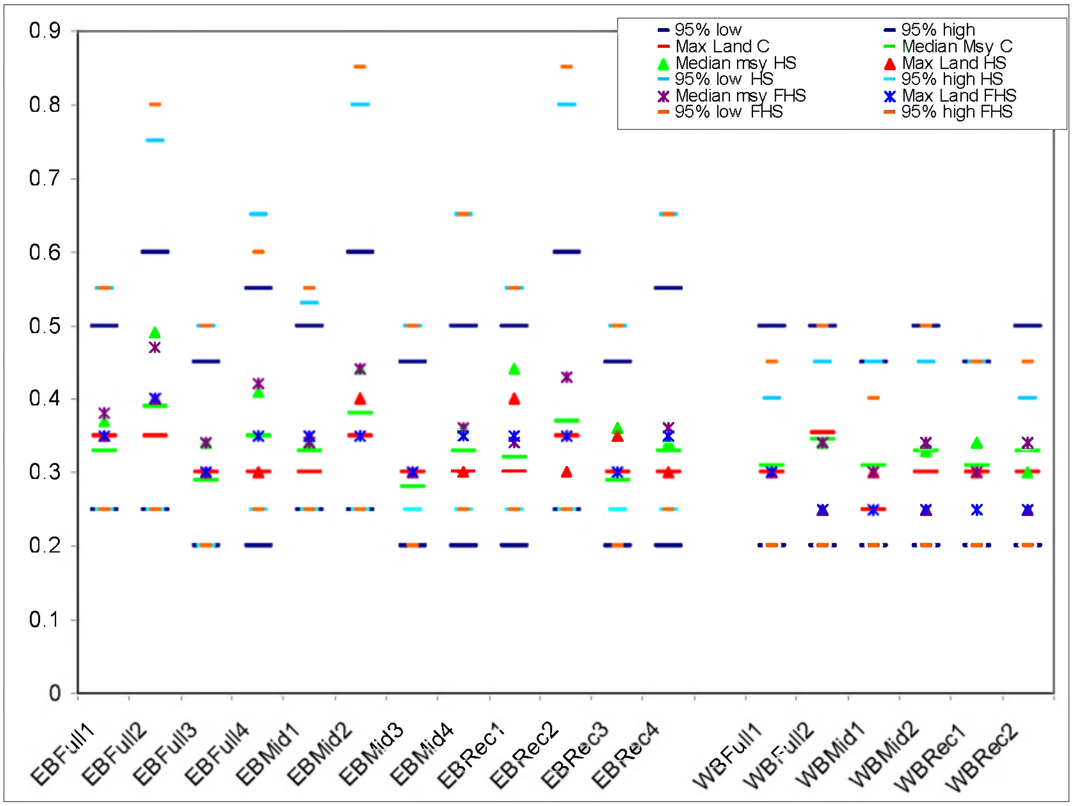

Figure 48 Comparison of fixed F exploitation estimates with full S-R model set and HS the fitted HS set from equilibrium exploitation of Eastern and Western Baltic cod. For twelve options for Eastern population and 6 options for Western population (see Table 1). For full S-R set Estimated Interval on F for exploitation >95% of Fmsy (—). Point estimate of Fmsy based on maximum landings (—) point estimate of Fmsy based on median population Fmsy(—). Assuming recruitment resilience (A parameter on S-R function) is common across stocks and data periods.

For HS S-R set estimated interval on F for exploitation >95% of Fmsy (—). Point estimate of Fmsy based on maximum landings (▲) point estimate of Fmsy based on median population Fmsy(▲). Assuming recruitment resilience (A parameter on HS S-R function) is common across stocks and data periods.

For non-varying parameter HS S-R set estimated interval on F for exploitation >95% of Fmsy (—). Point estimate of Fmsy based on maximum landings (*) point estimate of Fmsy based on median population Fmsy(*). Assuming recruitment resilience (A parameter on HS S-R function) is common across stocks and data periods.

Including the uncertainty in S-R functions gives

- more stable values for MSY targets and
- for Eastern Baltic cod narrower ranges of stable catch,
- for Western cod slightly wider ranges of catch stability

Exclusion of uncertainty in model type

- For Eastern Baltic cod higher targets and wider ranges
- for Western cod lower targets

Annex 2 Evaluation of Effort and TAC Quota Uptake and Capacity Use

EU STECF EWG-11-07 Working Document, June 2011

Effort Quota and Capacity by Country as well as efficiency of effort measures according to fishing mortality and fishing power in the Western and Eastern Baltic Cod Fishery during 2005-2010 in relation to the multi-annual cod management plan

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Krzysztof Radtke, Bent Pallisgaard, and Margit Eero

1.0 Introduction and Materials

At the joint ICES-STECF meeting of 28 Feb to 4 March 2011 (STECF EWG 11-01) the group was requested by the EU Commission and Member States to evaluate the effectiveness of a number of control measures in the Baltic cod long term (multi-annual) management plan (LTMP). In particular, STECF was requested to consider requirements for fishing effort limitations and TAC limitations for Eastern and Western Baltic cod management, to consider if the effort regime does or does not make a positive or negative impact on management, to consider to the extent to which the effort restrictions will help in achieving targets of the LTMP, and to consider if the management can be made simpler. To do this among other the following tasks were identified:

- Document effort and capacity ceilings by country
- Document to the extent to which effort quotas and TACs (in the management plan and previously) have been restrictive by fishery/métier/fleet and country through information from national administrations. Document actual quotas and quota uptake both for effort and TAC. List effort restrictions in relation to utilized capacity by country and fishery.
- Describe recent developments in compliance in relation to TAC and effort restrictions in the E. Baltic Sea and the W. Baltic Sea compared to historical information on this.
- In relation to values of baseline effort and utilized effort, evaluate the relationship between F and overall effort by management area and cod stock – and possibly by segment in relation to potential fishing power differences

In order to accomplish this, the EU Commission has sent a data request to the relevant national administrations of the member countries by 19th April 2011 to deliver the requested data by May 18th 2011.

Preliminary analyses on the data delivered by the National Administrations according to the data request and the above listed tasks is presented in table and graphical form in the present working document to EU STECF EWG 11-07.

The results on preliminary analyses of effort and TAC restrictions as well as capacity utilization by country are presented in sections 2 to 9 of this working document. Summary plots of this for the combined international Baltic cod fisheries are presented in section 10 referring to the conclusions made in section 12.

Furthermore, the materials, methods, results and conclusions on preliminary analysis of correlations between effort and fishing mortality as well as preliminary analyses of fishing power differences between fleet segments and fisheries are presented in sections 11 and 12 of this working document.

2.0 Results of preliminary analyses of effort and TAC and capacity restrictions by country

The listed tasks in the introduction have been addressed in preliminary analyses preparing summary tables and figures of effort and TAC and quota uptake as well as capacity ceilings and capacity utilization for each country according to various fisheries/fleets/metiers to show to which extent the quotas have been restrictive or not during the period 2005 to 2010 in the international Baltic cod fisheries and whether changes could be observed in quota up-take and capacity utilization in relation to introduction of the Baltic cod LTMP. The results and conclusions are shown separately by country in the sections below.

In general, there are (smaller) differences between countries in the methods used to estimate the effort and TAC quotas and quota up-take as well as in the estimation methods of capacity ceilings and capacity utilization (i.e. methods of categorizing, defining and estimating this) by the respective national administrations. However, it should be noted that in relation to introduction of the cod management plan during the period 2007-2008 and evaluation of potential changes in utilization according to this there will be full comparability of the estimates over the years within the country for each country in the period 2005-2010, and stronger trends in differences between countries will also be directly comparable.

The reported effort in the above mentioned data call only cover regulated gears.

In relation to the information obtained from the national administrations on capacity under the above mentioned data call it should be noticed that data provided on capacity ceilings varied from country to country. The capacity ceiling, measured in kW, should be established in accordance with article 10(2) of Council Regulation 1098/2007, for vessels holding special cod fishing permits in 2005. For capacity calculations the capacity ceilings are set at a certain level for each country, taking 2005 as reference year. Furthermore it has to be noted that data on the number of cod permits granted can differ as these partly include vessels holding a special permit for fishing cod which were inactive and partly vessels holding a special permit for fishing cod that were active during that year. Calculations on the number of fishing permits related to numbers of active vessels by gear and area are therefore not included in the analysis.

ICES Subdivision 27, 28.2 and 28.1 have been excluded from fishing effort restrictions, therefore this should be taken into account when effort information is delivered. Member States was asked to exclude data from these subdivisions when filling in the tables.

Table 2.1 Effort ceilings by vessel for the Eastern and Western Baltic Sea for the period 2006-2011 (from EU STECF SGMOS-11-06)

Area	2006 (closed days)	2007(closed days)	2008 (days at sea)	2009 (days at sea)	2010 (days at sea)	2011 (days at sea)
22-24	92	117	223	201	181	163
25-28	119*	183*	178**	160**	160 **	160 **

*There was no closed periods in Sub-divisions 28-32 in 2006-2007

** There was no closed periods in Sub-divisions 29-32 in 2008-2011

It should be noted that present fishing mortality for both the Eastern and Western Baltic cod stocks in 2011 is assessed to be below F_{TARGET} resulting in either constant or an actual increase of the effort ceilings for 2012 for both stocks as well as for the Eastern Baltic cod for 2011 also.

3.0 Denmark (DK): Results and conclusions

Table 3.1 Total effort summed by year for all Danish vessels divided by fleet 2005-2010 for vessels fishing in the Western Baltic Sea (Area A) and the Eastern Baltic Sea (Area B)

	Column Labels											
	Sum of A						Sum of B					
Row Labels	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
DEM_SEINE	0	0	0	0		0	0	0	0	0		0
DEM_SEINE >=105	1359	1223	1106	849	567	444	42	49	17	0	0	0
DEM_SEINE 90-105	6	34					0	0				
GILL	10253	9137	7173	7104	6445	7168	1362	1389	1098	1184	1208	817
GILL >=220	72	208	8	52	46	80	176	268	0	0	1	0
GILL 100-10	77	31	7	42	60	4	0	0	0	0	0	0
GILL 110-15	12976	12136	10019	9340	7791	6905	2138	2654	2316	2238	1911	1603
GILL 157-21	2615	1736	1854	2298	2305	1836	227	212	134	256	208	65
GILL 90-99	1		4	10			0		0	0		
LONGLINE	154	0	32	26	42	49	0	99	133	101	112	121
LONGLINE >=220	1814	1205	310	191	344	315	968	1312	343	276	311	288
LONGLINE 10-30	15	2		1			40	0		0		
LONGLINE 70-79	140						0					
LONGLINE 90-99					2						0	
OTHER	23	100	155	4	4	10	0	81	0	0	0	0
OTTER	469	472	630	515	516	623	43	0	9	165	143	82
OTTER >=105	16222	10478	8999	8042	7282	6089	3685	5715	2708	2540	2650	3029
OTTER 90-105	286	388	282	427	402	509	0	0	0	0	0	0
PEL_TRAWL >=105	2	54	0			1	33	193	64			17
PEL_TRAWL 90-105			4	2		20			0	0		0
POTS	32	32	30	41	53	55	0	0	0	0	0	0
TRAMMEL >=220			2	73		52			200	0		0
TRAMMEL 110-15	3844	3913	3511	3462	3506	3168	0	0	0	0	0	0
TRAMMEL 157-21	474	329	617	637	933	746	0	0	0	0	146	0
Grand Total	**50834**	**41478**	**34743**	**33116**	**30298**	**28074**	**8714**	**11972**	**7022**	**6760**	**6690**	**6022**

Table 3.2 Effort used for vessels < 8 m vessel length. Denmark has no allowed effort for this group of vessels. Definition for days at sea is 1 day per date of landing per area.

	Western Baltic	Eastern Baltic
	Effort used /days at sea	Effort used /days at sea
2005	10,871	1,405
2006	9,659	1,488
2007	7,981	1,250
2008	7,826	1,450
2009	7,056	1,463
2010	8,001	1,020

Figure 3.1 Percent effort quota (fishing days) uptake by vessel for all years during the period 2005-2010 having quota in the Western Baltic Sea (Area A) and/or the Eastern Baltic Sea (Area B).

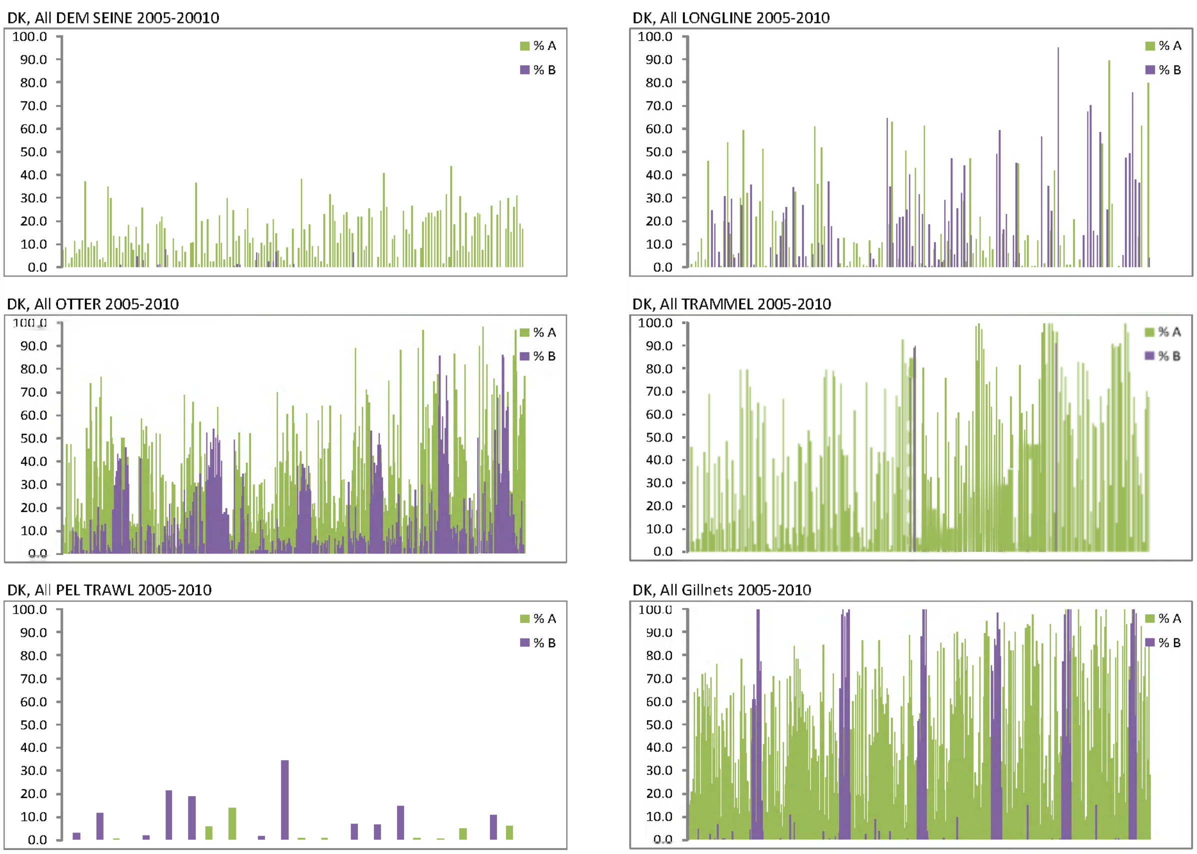


Figure 3.2 Percent effort quota (fishing days) uptake by gillnet vessels per year during the period 2005-2010 having quota in the Western Baltic Sea (Area A) and/or the Eastern Baltic Sea (Area B).

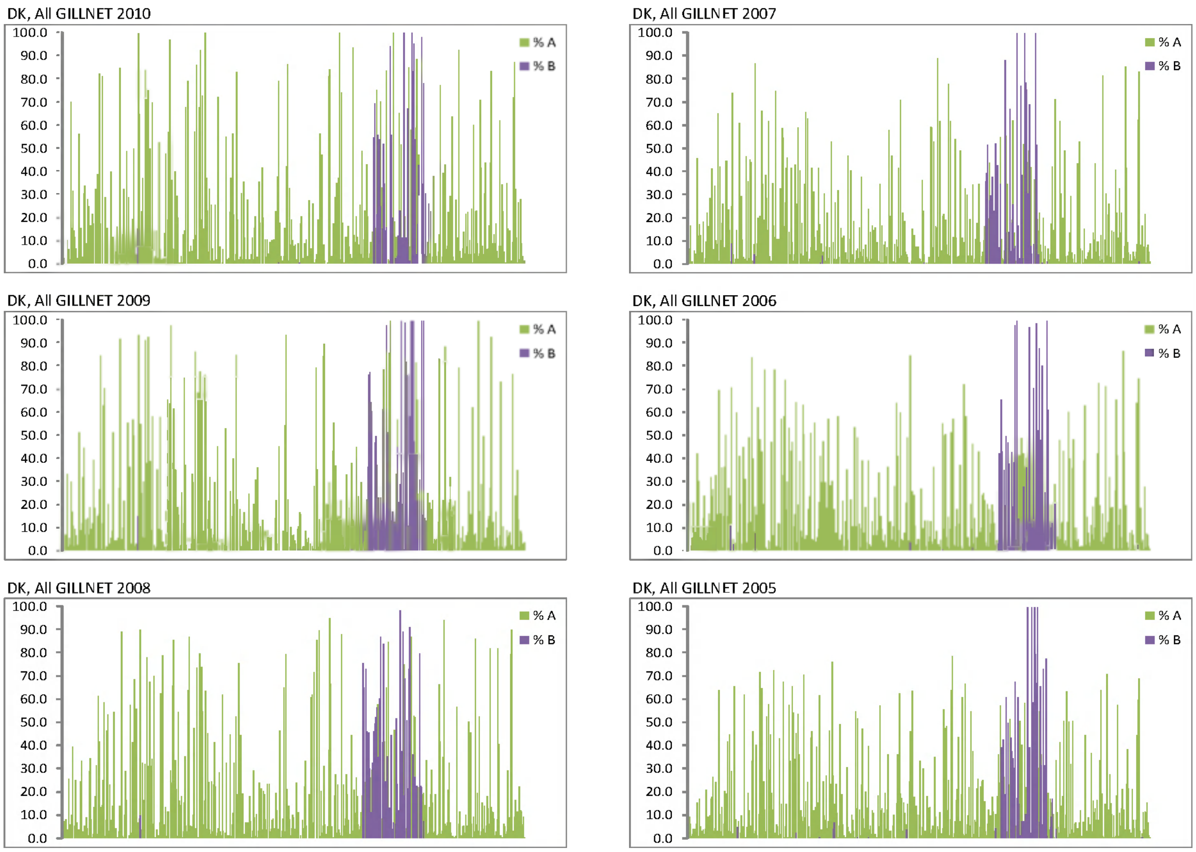


Figure 3.3 Percent effort quota (fishing days) uptake by otter board vessels per year during the period 2005-2010 having quota in the Western Baltic Sea (Area A) and/or the Eastern Baltic Sea (Area B).

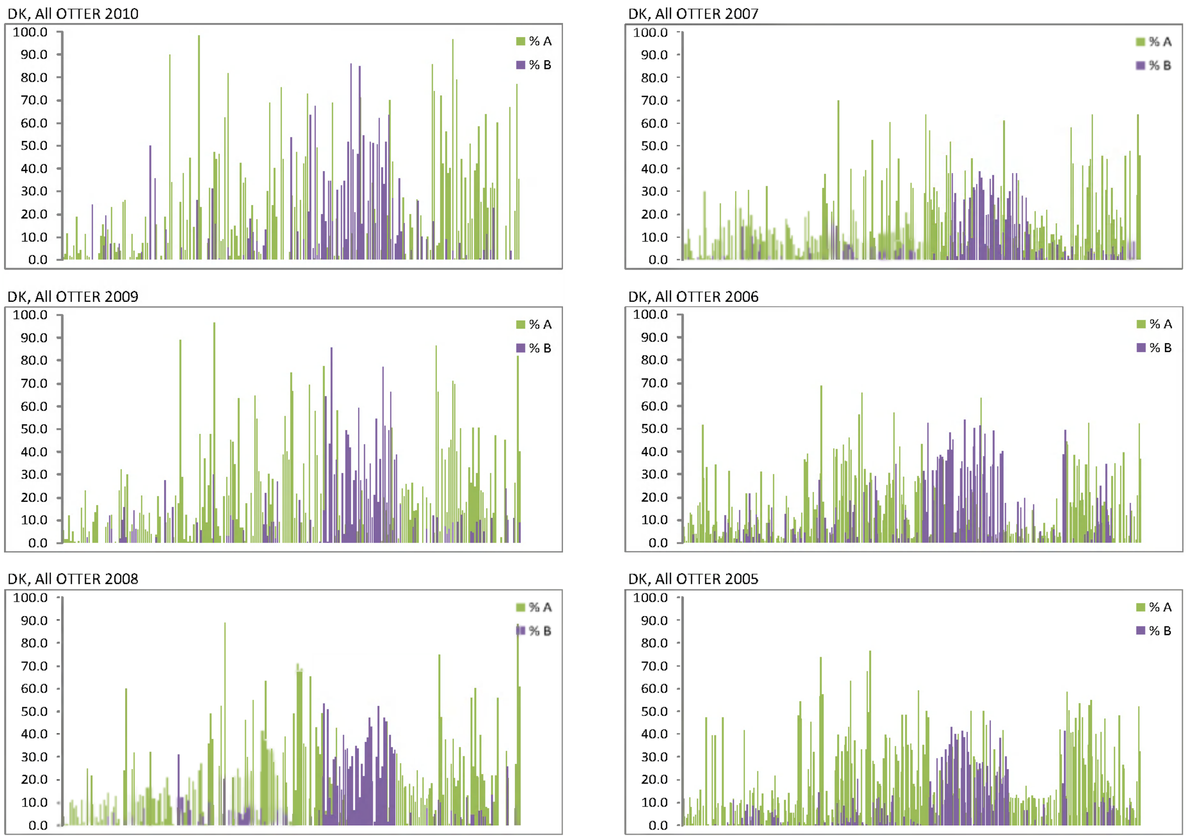
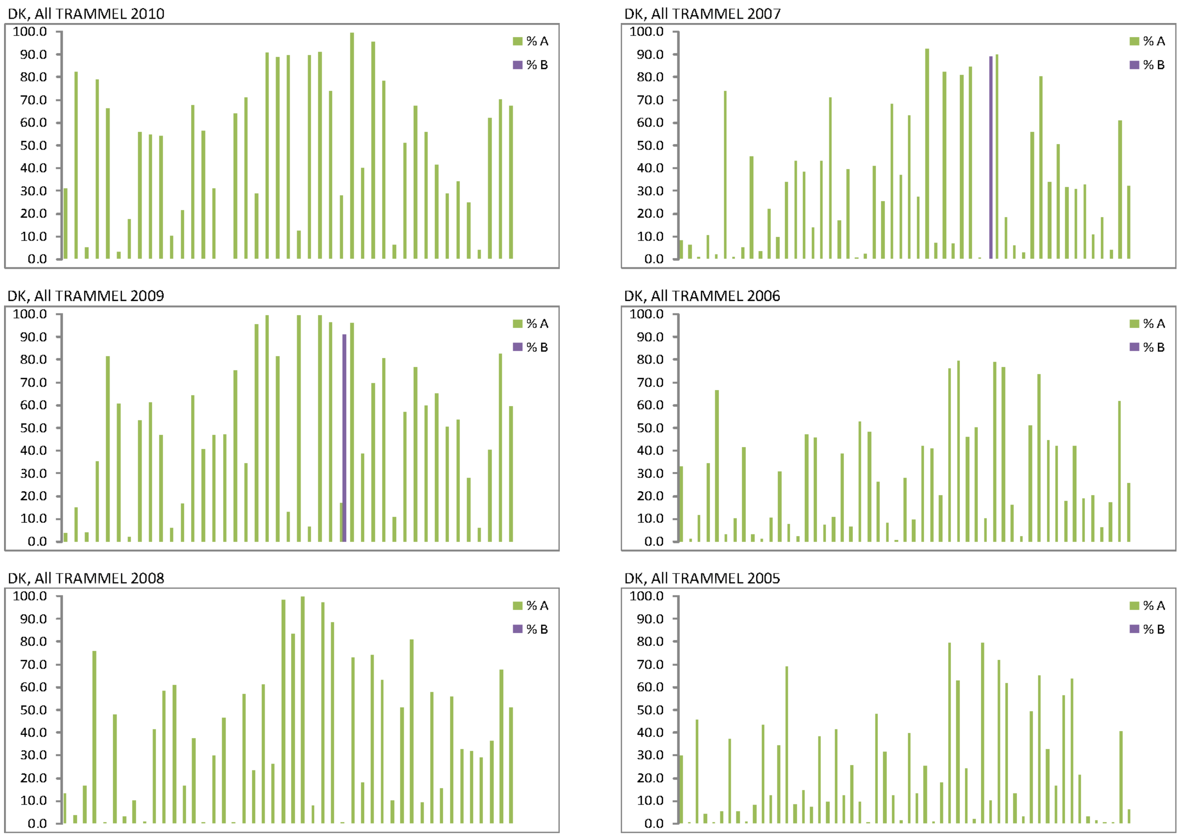


Figure 3.4 Percent effort quota (fishing days) uptake by trammel net vessels per year during the period 2005-2010 having quota in the Western Baltic Sea (Area A) and/or the Eastern Baltic Sea (Area B).

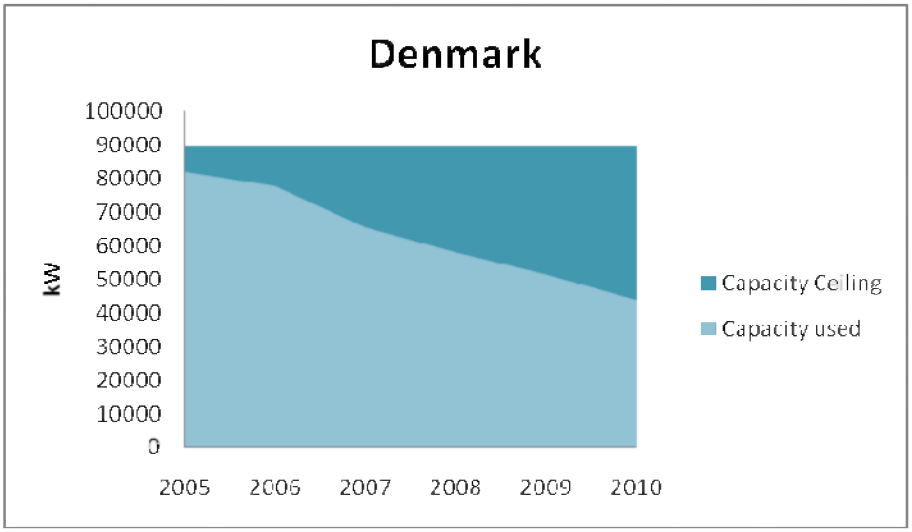


The LTMP has been in force since 2007. Effort limitations appear to have been restrictive to limited extent during the period 2005-2010, and for certain vessels and areas (e.g. gillnetters in the Eastern Baltic Sea) the restrictions appears to have been there for all years of the period. However, there is a tendency towards an increasing proportion of the effort quota is fully used over time especially for otter board trawlers in both areas as well as gillnetters and trammel netters in the Western Baltic Sea area. In case of continued effort reductions according to the implementation of the management plan then the effort can be expected to be more restrictive for more vessels in the coming years for these vessels. The types of vessels where restrictions are observed are gillnet, otter board trawl and trammel net vessels.

Table 3.2 Denmark . National cod quota (TAC) by management area and quota uptake.

	National quota				Quota uptake (landings)				Quota Uptake in %		
Management area	A	B	C	A+B+C	A	B	C	A+B+C	A	B	A+B+C
2005	13,238	6,327		19,565	13,367	5,677		19,044	101.0	89.7	97.3
2006	14,717	8,915		23,632	12,933	8,454		21,387	87.9	94.8	90.5
2007	13,713	7,222		20,935	12,259	6,165		18,424	89.4	85.4	88.0
2008	10,963	7,612		18,575	9,800	7,097		16,897	89.4	93.2	91.0
2009	9,388	8,602		17,990	8,171	7,968		16,139	87.0	92.6	89.7
2010	8,176	10,862		19,038	7,266	10,347		17,613	88.9	95.3	92.5

Figure 3.5 Capacity ceiling in relation to capacity utilization for the Baltic Sea for the period 2005-2010



In accordance with article 10 (2) of Council Regulation 1098/2007, taking the year 2005 as reference year, the capacity ceiling for Denmark is set at 89520 kW. The capacity was not fully used and decreased by 42.7% in relation to the capacity ceiling between the years 2005 and 2010 and by 24.1% after the management plan had been established. For Denmark, fishing permits are not divided into different areas in the Baltic Sea. The permits are valid for the whole Baltic Sea.[1]

4.0 Germany (DE)

Table 4.1 Total effort summed by year for all German vessels divided by fleet 2005-2010 for vessels fishing in the Western Baltic Sea (Area A) and the Eastern Baltic Sea (Area B)

	Data	Year										
	Sum of A						Sum of B					
Main Gear	2005	2006	2007	2008	2009	2010	2005	2006	2007	2008	2009	2010
--	0	0	0	0	0	0	0	0	0	0	0	0
Mobile gear	8466	7677	7580	6282	5371	4827	2004	1168	543	773	1228	1598
Passive gear	14368	19186	16305	16477	13639	11987	386	83	56	20	49	0
Grand Total	22834	26863	23885	22759	19010	16814	2390	1251	599	793	1277	1598

[1] Source: Danish Directorate of Fisheries Vessel-, Logbook- and Fishing Permit Register

Table 4.2 Total effort allowed and total effort used by German vessel type and vessel length groups by year in the period 2005-2010

COUNTRY	GERMANY											
Trawl Fishery	Eastern Baltic											
	8-10		10-12		12-18		18-24		24-40		>40	
	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used
2005	0	0	4,380	95	9,855	453	6,935	783	4,015	673	0	0
2006	0	0	1,230	39	3,690	212	4,428	426	3,198	491	0	0
2007	0	0	666	27	1,110	33	1,998	211	2,220	272	0	0
2008	0	0	890	49	2,492	219	2,492	298	1,602	207	0	0
2009	0	0	1,440	120	3,360	346	2,720	527	1,120	235	0	0
2010	0	0	1,440	178	3,040	491	2,720	629	1,280	300	0	0

COUNTRY	GERMANY											
Trawl Fishery	Eastern + Western Baltic											
	8-10		10-12		12-18		18-24		24-40		>40	
	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used
2005	2,190	216	10,585	1,631	20,440	4,335	9,855	2,725	4,015	1,563	0	0
2006	2,192	402	7,124	1,560	14,796	3,608	7,124	2,158	3,562	1,117	0	0
2007	1,984	289	5,456	1,263	13,144	3,512	7,688	2,096	2,728	963	0	0
2008	1,115	301	5,352	1,332	10,927	3,279	5,575	1,651	2,230	492	0	0
2009	1,005	245	4,221	1,054	9,447	3,028	4,824	1,741	1,608	531	0	0
2010	724	219	3,801	1,108	7,964	3,006	4,706	1,552	1,448	540	0	0

Table 4.3 Total effort allowed and total effort used by German vessel type and vessel length groups by year in the period 2005-2010

COUNTRY	GERMANY											
Gillnet Fishery	Western Baltic											
	8-10		10-12		12-18		18-24		24-40		>40	
	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used
2005	36,865	6,461	23,725	6,082	5,475	976	0	0	0	0	0	0
2006	33,154	10,894	18,084	6,112	4,658	933	0	0	0	0	0	0
2007	28,024	9,591	15,128	4,967	3,472	909	0	0	0	0	0	0
2008	26,314	9,605	13,380	4,972	3,791	1,032	0	0	0	0	0	0
2009	23,115	7,785	12,261	3,999	3,417	708	0	0	201	6	0	0
2010	19,186	7,089	11,222	3,810	2,353	413	0	0	0	0	0	0

COUNTRY	GERMANY											
Gillnet Fishery	Eastern Baltic											
	8-10		10-12		12-18		18-24		24-40		>40	
	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used
2005	2,190	47	4,745	182	2,920	149	0	0	0	0	0	0
2006	246	6	738	12	984	63	0	0	0	0	0	0
2007	0	0	0	0	444	56	0	0	0	0	0	0
2008	0	0	0	0	356	20	0	0	0	0	0	0
2009	160	20	160	12	480	17	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0	0	0	0	0

COUNTRY	GERMANY											
Gillnet Fishery	Eastern + Western Baltic											
	8-10		10-12		12-18		18-24		24-40		>40	
	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used
2005	36,865	6,508	23,725	6,264	5,840	1,125	0	0	0	0	0	0
2006	33,154	10,900	18,084	6,124	4,658	996	0	0	0	0	0	0
2007	28,024	9,591	15,128	4,967	3,472	965	0	0	0	0	0	0
2008	26,314	9,605	13,380	4,972	3,791	1,052	0	0	0	0	0	0
2009	23,115	7,805	12,261	4,011	3,417	725	0	0	201	6	0	0
2010	19,186	7,089	11,222	3,810	2,353	413	0	0	0	0	0	0

Table 4.4 Total effort allowed and total effort used by German vessel type and vessel length groups by year in the period 2005-2010

COUNTRY	GERMANY											
Other Fishery	Western Baltic											
	8-10		10-12		12-18		18-24		24-40		>40	
	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used
2005	5,475	284	9,125	729	1,460	178	0	0	0	0	0	0
2006	7,398	600	6,850	533	1,644	114	0	0	0	0	0	0
2007	5,456	382	5,208	406	992	45	248	5	0	0	0	0
2008	4,683	378	5,129	434	1,115	56	0	0	0	0	0	0
2009	5,226	505	4,221	557	1,407	79	0	0	0	0	0	0
2010	3,982	264	3,801	373	362	38	0	0	0	0	0	0

COUNTRY	GERMANY											
Other Fishery	Eastern Baltic											
	8-10		10-12		12-18		18-24		24-40		>40	
	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used
2005	0	0	730	6	365	2	0	0	0	0	0	0
2006	0	0	246	2	0	0	0	0	0	0	0	0
2007	0	0	0	0	0	0	0	0	0	0	0	0
2008	0	0	0	0	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0	0	0	0	0

COUNTRY	GERMANY											
Other Fishery	Eastern + Western Baltic											
	8-10		10-12		12-18		18-24		24-40		>40	
	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used
2005	5,475	284	9,125	735	1,460	180	0	0	0	0	0	0
2006	7,398	600	6,850	535	1,644	114	0	0	0	0	0	0
2007	5,456	382	5,208	406	992	45	248	5	0	0	0	0
2008	4,683	378	5,129	434	1,115	56	0	0	0	0	0	0
2009	5,226	505	4,221	557	1,407	79	0	0	0	0	0	0
2010	3,982	264	3,801	373	362	38	0	0	0	0	0	0

There is no information available from Germany on effort used by vessels less than 8 m in vessel length.

Figure 4.1 Percent effort quota (fishing days) uptake by vessel for all years during the period 2005-2010 having quota in the Western Baltic Sea (Area A) and/or the Eastern Baltic Sea (Area B).

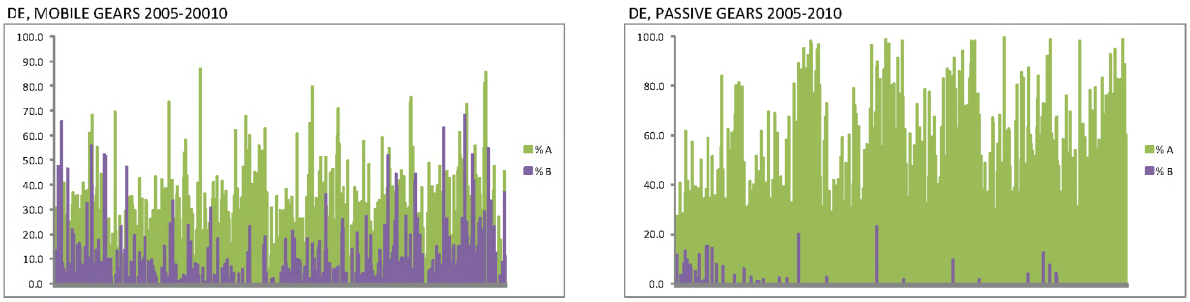
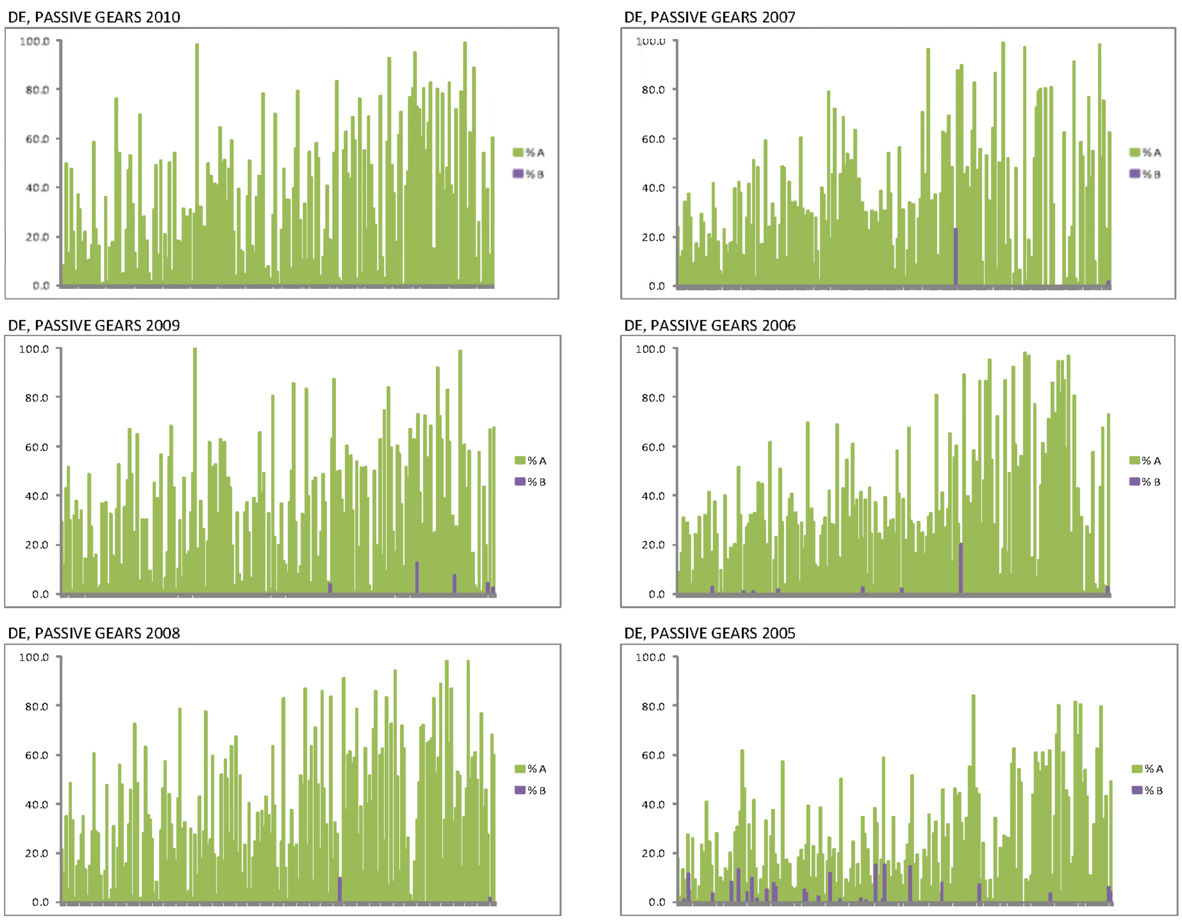


Figure 4.2 Percent effort quota (fishing days) uptake by passive gear vessels per year during the period 2005-2010 having quota in the Western Baltic Sea (Area A) and/or the Eastern Baltic Sea (Area B).

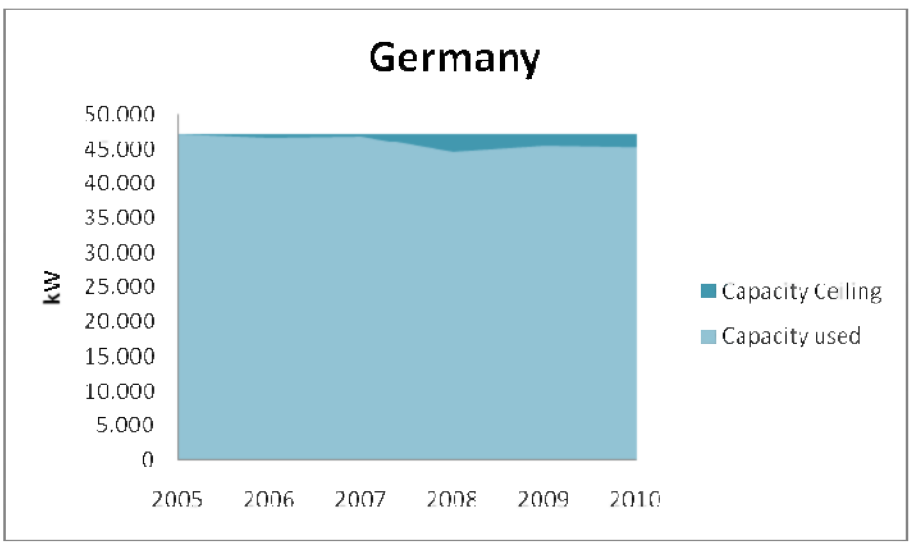


Effort limitations appear to have been restrictive to limited extent during the period 2005-2010 for German vessels, which is especially the case for passive gear vessels during the period 2006-2010 in the Western Baltic Sea. However, there is a tendency towards an increasing proportion of the effort quota is fully used over time especially for passive gear vessels in the Western Baltic Sea. In case of continued effort reductions according to the implementation of the management plan then the effort can be expected to be more restrictive for more vessels in the coming years. There seems not to have been restrictions according to effort quotas for German active gear vessels in any of the areas.

Table 4.5 Germany . National cod quota (TAC) by management area and quota uptake.

COUNTRY: GERMANY	National quota				Quota uptake (landings)				Quota Uptake in %		
Management area	A	B	C	A+B+C	A	B	C	A+B+C	A	B	A+B+C
2005	5,271	3,564	_	8,835	7,003	2,342	_	9,345	132.9	65.7	105.8
2006	6,061	4,143	_	10,204	7,532	2,025	_	9,557	124.3	48.9	93.7
2007	5,697	3,729	_	9,426	7,617	1,529	_	9,146	133.7	41.0	97.0
2008	4,102	3,542	_	7,644	5,489	2,341	_	7,830	133.8	66.1	102.4
2009	3,487	4,074	_	7561	4,020	3,229	_	7,249	115.3	79.3	95.9
2010	3,777	4,685	_	8,462	4,250	3,908	_	8,158	112.5	83.4	96.4

Figure 4.3 Capacity ceiling in relation to capacity utilization for the Baltic Sea for the period 2005-2010



The capacity ceiling was established in accordance with article 10 (2) of Council Regulation 1098/2007. It was almost fully utilised during the period 2005-2010. The capacity utilisation exhibits a reduction of 5.4% between 2005 and 2008. It shows an increase in 2009 and a slight decrease in 2010.

5.0 Sweden (SE): Results and conclusions

Table 5.1 Total effort summed by year for all Swedish vessels divided by fleet 2005-2010 for vessels fishing in the Western Baltic Sea (Area A) and the Eastern Baltic Sea (Area B)

	Year Data											
	2005		2006		2007		2008		2009		2010	
Main Gear	Sum of A	Sum of B	Sum of A	Sum of B	Sum of A	Sum of B	Sum of A	Sum of B	Sum of A	Sum of B	Sum of A	Sum of B
Gillnet	7421	10697	6472	9661	6273	8013	6984	8789	5919	8119	4949	5562
Other	977	4044	446	3768	374	2211	254	2690	402	2139	400	1262
Trawl	593	4400	807	4631	956	2914	723	2910	411	2595	330	2859
Grand Total	8991	19141	7725	18060	7603	13138	7961	14389	6732	12853	5679	9683

Table 5.2 Total effort allowed and total effort used by Swedish vessel type and vessel length groups by year in the period 2005-2010

Country												
TRAWL Fishery*	**Western Baltic**											
	8-10		10-12		12-18		18-24		24-40		>40	
	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used
2005	0	0	304	2	5776	365	4864	152	3040	74	0	0
2006	0	0	274	30	5206	270	5480	363	3014	144	0	0
2007	248	1	496	19	4960	305	4464	405	3968	226	0	0
2008	0	0	446	10	3568	170	4237	354	2453	189	0	0
2009	0	0	603	7	2211	126	2814	195	1407	83	0	0
2010	0	0	0	0	1448	87	2353	176	1267	67	0	0

Country												
TRAWL Fishery*	**Eastern Baltic**											
	8-10		10-12		12-18		18-24		24-40		>40	
	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used
2005	227	4	454	54	6129	1353	5675	1713	3178	1276		
2006	247	10	1235	144	4693	1082	5681	1887	3952	1508		
2007	0		666	99	4218	661	5994	1199	4218	955		
2008	0		712	209	3026	700	4806	1238	3026	763		
2009	160	30	480	156	2880	797	4000	1008	2560	604		
2010	0		160	69	2080	799	4000	1360	1920	631		

Table 5.3 Total effort allowed and total effort used by Swedish vessel type and vessel length groups by year in the period 2005-2010

Country												
GILLNET Fishery**	**Western Baltic**											
	8-10		10-12		12-18		18-24		24-40		>40	
	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used
2005	12464	2891	10336	3096	1824	406	0	0	0	0	0	0
2006	8494	2618	9864	2664	1918	286	274	13	0	0	0	0
2007	8680	2447	8928	2624	1240	376	0	0	0	0	0	0
2008	8028	2671	8474	3083	1338	398	0	0	0	0	0	0
2009	7236	2322	8241	2823	1005	393	0	0	0	0	0	0
2010	6154	2059	6697	2217	1267	334	0	0	0	0	0	0

Country												
GILLNET Fishery**	**Eastern Baltic**											
	8-10		10-12		12-18		18-24		24-40		>40	
	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used
2005	15663	3622	14074	3522	6356	1900	227	105	0	0	0	0
2006	14820	3386	14326	3039	6175	1543	247	25	0	0	0	0
2007	12876	3176	11100	2352	4662	930	0	0	0	0	0	0
2008	10146	3708	8900	2831	3026	1015	178	44	0	0	0	0
2009	8480	3186	9600	2911	2080	757	0	0	0	0	0	0
2010	7200	2451	8480	2150	1600	411	0	0	0	0	0	0

Table 5.4 Total effort allowed and total effort used by Swedish vessel type and vessel length groups by year in the period 2005-2010

Country OTHER Fishery***	Western Baltic											
	8-10		10-12		12-18		18-24		24-40		>40	
	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used
2005	3952	167	3648	576	1520	146	304	5	0	0	0	0
2006	2192	79	5206	224	822	81	0	0	548	6	0	0
2007	2480	92	3224	160	744	30	0	0	744	9	0	0
2008	1338	15	2899	162	446	2	0	0	0	0	0	0
2009	1005	37	3216	349	402	14	0	0	0	0	0	0
2010	1086	61	3077	287	362	38	0	0	181	3	0	0

Country OTHER Fishery***	Eastern Baltic											
	8-10		10-12		12-18		18-24		24-40		>40	
	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used
2005	7718	1327	8626	1573	3859	536	0	0	0	0	0	0
2006	8645	1326	9386	1449	2964	546	0	0	247	2	0	0
2007	6438	865	5772	803	1554	185	0	0	444	2	0	0
2008	5162	1230	4450	1069	1068	93	0	0	0	0	0	0
2009	4320	990	4000	841	800	123	0	0	0	0	0	0
2010	2720	515	3200	560	800	109	0	0	0	0	0	0

Table 5.5 Effort used for Swedish vessels < 8 m vessel length.

Country	Western Baltic		Eastern Baltic		Eastern + Western Baltic	
	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used
2005		1111		2156		3267
2006		947		2113		3060
2007		909		1911		2820
2008		907		1489		2396
2009		383		1450		1833
2010		350		628		978

Figure 5.1 Percent effort quota (fishing days) uptake by vessel for all years during the period 2005-2010 having quota in the Western Baltic Sea (Area A) and/or the Eastern Baltic Sea (Area B).

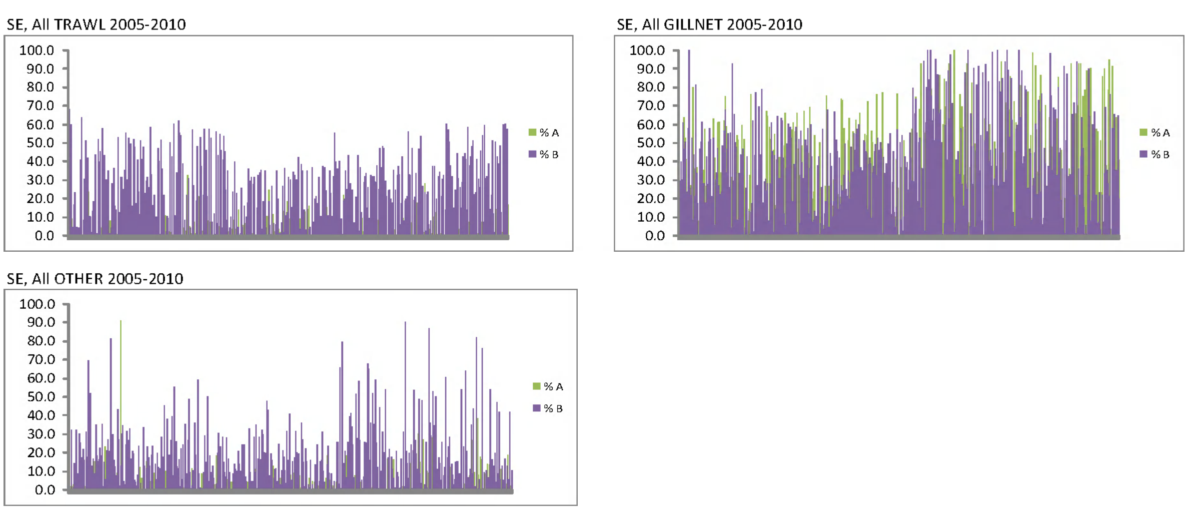
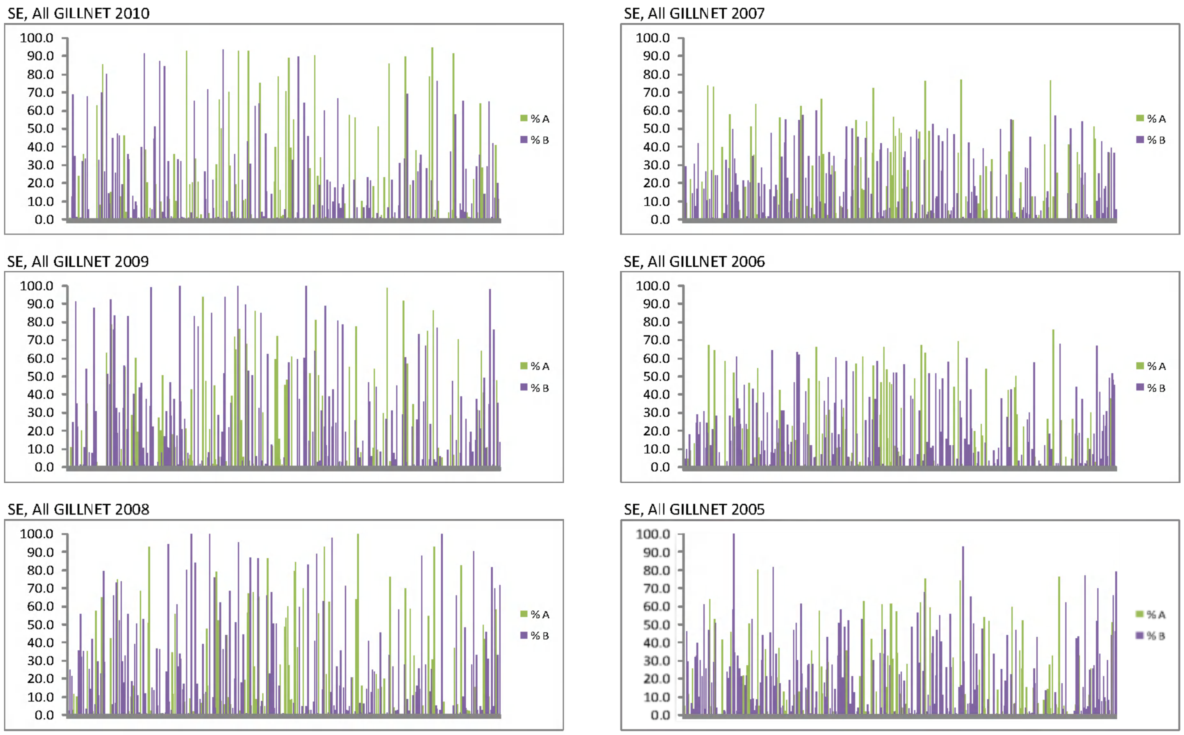


Figure 5.2 Percent effort quota (fishing days) uptake by gillnet vessels per year during the period 2005-2010 having quota in the Western Baltic Sea (Area A) and/or the Eastern Baltic Sea (Area B).

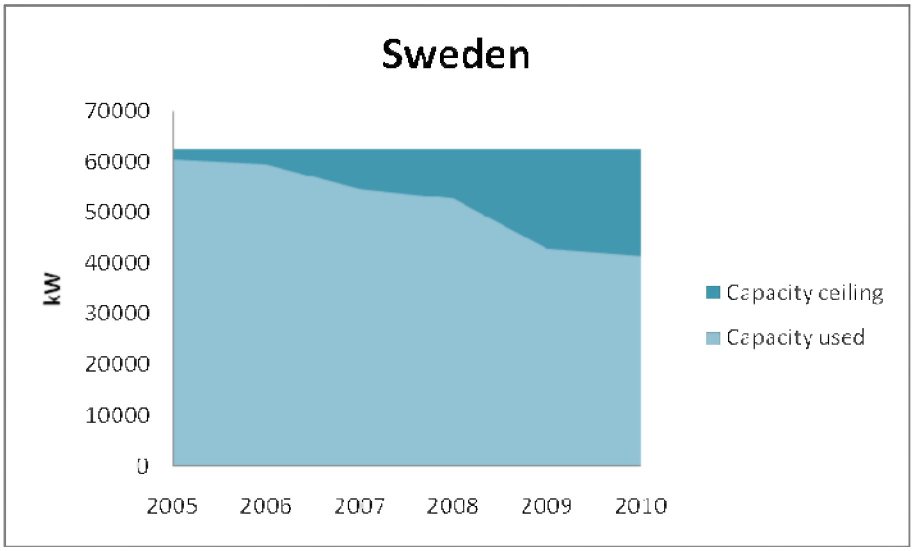


Effort limitations appear to have been restrictive to limited extent during the period 2008-2010 for Swedish vessels, which is especially the case for gillnet vessels during the period 2008-2010 in the Eastern but also the Western Baltic Sea. There is as such a tendency towards an increasing proportion of the effort quota is fully used over time especially for gillnet vessels in the Eastern Baltic Sea. In case of continued effort reductions according to the implementation of the management plan then the effort can be expected to be more restrictive for more vessels in the coming years. There seems not to have been restrictions according to effort quotas for Swedish trawl gear and other gear vessels in any of the areas.

Table 5.6 Sweden . National cod quota (TAC) by management area and quota uptake.

Country	National quota					Quota uptake (landings)					Quota Uptake in %		
	A	B	A+B	C	A+B+C	A	B	A+B	C	A+B+C	A	B	A+B+C
2005	2393	10192	12585		12585	2375	8288	10663		10663	99.2	81.3	84.7
2006	2917	10852	13769		13769	2632	9826	12458		12458	90.2	90.5	90.5
2007	3602	10657	13405		13405	2960	9750	12710		12710	82.2	91.5	94.8
2008	3039	9022	12061		12061	2756	8961	11717		11717	90.7	99.3	97.1
2009	2723	10375	13098		13098	2069	10121	12190		12190	76.0	97.6	93.1
2010	2753	11932	14685		14685	1591	9994	11585		11585	57.8	83.8	78.9

Figure 5.3 Capacity ceiling in relation to capacity utilization for the Baltic Sea for the period 2005-2010



The capacity ceiling was set in accordance to article 10 (2) of Council Regulation 1098/2007. The capacity utilization for Sweden exhibited a decline of 30.1% from 2005 to 2010 and of 21% after the management had been established.

6.0 Poland (PL): Results and conclusions

Table 6.1 Total effort allowed and total effort used by Polish vessel type and vessel length groups by year in the period 2005-2010, as well as total effort summed by year for all Polish vessels divided by fleet 2005-2010 for vessels fishing in the Western Baltic Sea (Area A) and the Eastern Baltic Sea (Area B)

			8-10		10-12		12-18		18-24		24-40	
AREA_ABC	GEAR	Year	effort allowed	effort used	effort allowed	effort used	effort allowed	effort used	effort allowed	effort used	effort allowed	effort used
Western Baltic	Trawls	2005	608	2	912	36	10,944	773	3,648	177	10,032	413
		2006			1,096	38	3,836	184	822	72	5,480	298
		2007	496	97	992	99	5,456	697	3,968	469	8,184	1020
		2008	446	25	1,115	69	4,906	632	1,784	156	5,798	441
		2009	804	91	1,005	63	5,025	535	1,206	148	1,608	103
		2010	362	55	1,267	92	3,801	470	724	65	724	36
	Gillnetters	2005	20,672	1580	11,856	1088	17,632	1342	1,216	88	608	75
		2006	13,152	1184	7,124	802	6,302	655	548	15		
		2007	18,104	1549	9,920	1115	11,904	1317	992	81		
		2008	12,265	1203	7,582	860	8,251	786	669	63		
		2009	7,638	950	3,819	606	2,814	335	201	23		
		2010	3,982	447	2,896	398	1,629	284				
	Other Gears	2005	6,080	282	11,552	433	14,896	831	608	22	304	32
		2006	2,466	162	4,384	115	4,658	259	274	4		
		2007	5,952	287	4,960	163	6,448	243				
		2008	2,676	87	1,338	36	2,899	108				
		2009	2,010	84	804	39						
		2010	1,267	41	1,267	44	181	1				
Eastern Baltic	Trawls	2005	681	21	681	94	19,976	5378	10,896	3921	27,240	6913
		2006	246	28	984	148	15,006	5643	9,102	4887	21,648	8007
		2007	666	95	666	165	11,988	3296	8,214	3088	17,538	4453
		2008	356	175	712	169	10,324	2568	6,230	2009	10,858	2166
		2009	320	63	800	265	6,720	2326	3,680	1026	4,160	1010
		2010	160	83	800	330	6,880	2818	3,360	1220	4,960	1121
	Gillnetters	2005	48,578	11877	15,890	3397	30,645	8165	3,405	963	3,405	1040
		2006	43,788	9916	14,760	2937	27,306	8037	2,460	624	1,230	321
		2007	35,520	9064	11,988	2515	21,978	5478	1,776	416	222	49
		2008	27,234	7582	9,434	3288	13,706	2947	712	255		
		2009	22,720	6602	8,640	3382	4,960	1554	320	10		
		2010	21,280	5657	8,000	3229	4,960	1790	320	184		
	Other Gears	2005	21,338	2554	12,258	1959	18,160	3018	681	90	454	31
		2006	20,418	2956	12,546	2372	15,252	3157	246	4		
		2007	17,094	1882	9,990	1484	13,764	1552	222	12		
		2008	11,570	1411	7,120	667	7,654	598	178	6		
		2009	3,680	313	2,880	302	960	88				
		2010	5,600	987	4,000	768	1,120	190				

Table 6.2 Effort used for Polish vessels < 8 m vessel length.

	A		B	
Year	**effort allowed**	**effort used**	**effort allowed**	**effort used**
2005	11,552	889	65,830	23149
2006	7,124	689	64,698	18453
2007	8,928	879	54,168	16544
2008	8,474	795	43,788	13220
2009	8,040	770	41,120	16429
2010	5,792	499	40,160	13611

Figure 6.1 Percent effort quota (fishing days) uptake by vessel for all years during the period 2005-2010 having quota in the Western Baltic Sea (Area A) and/or the Eastern Baltic Sea (Area B).

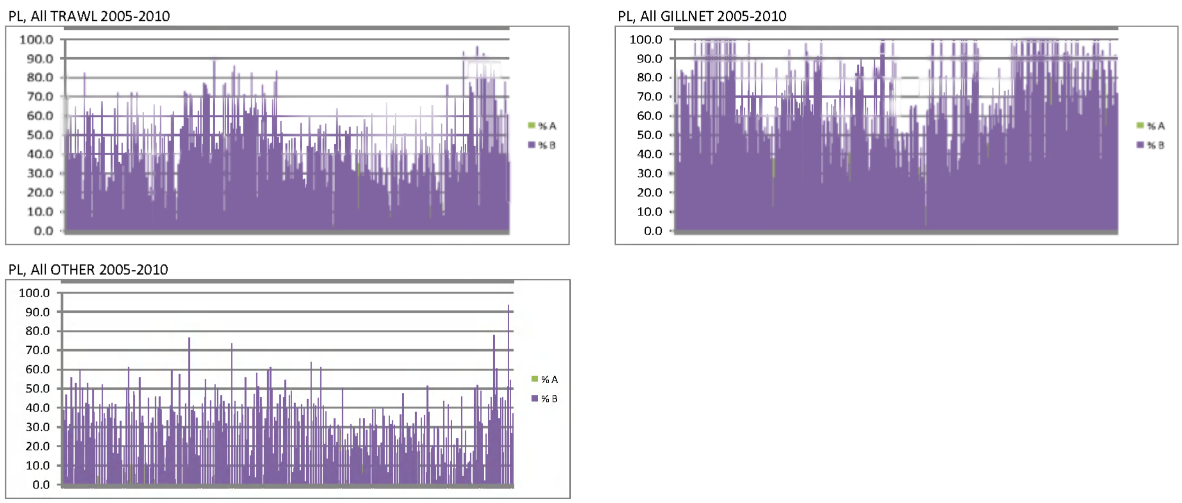
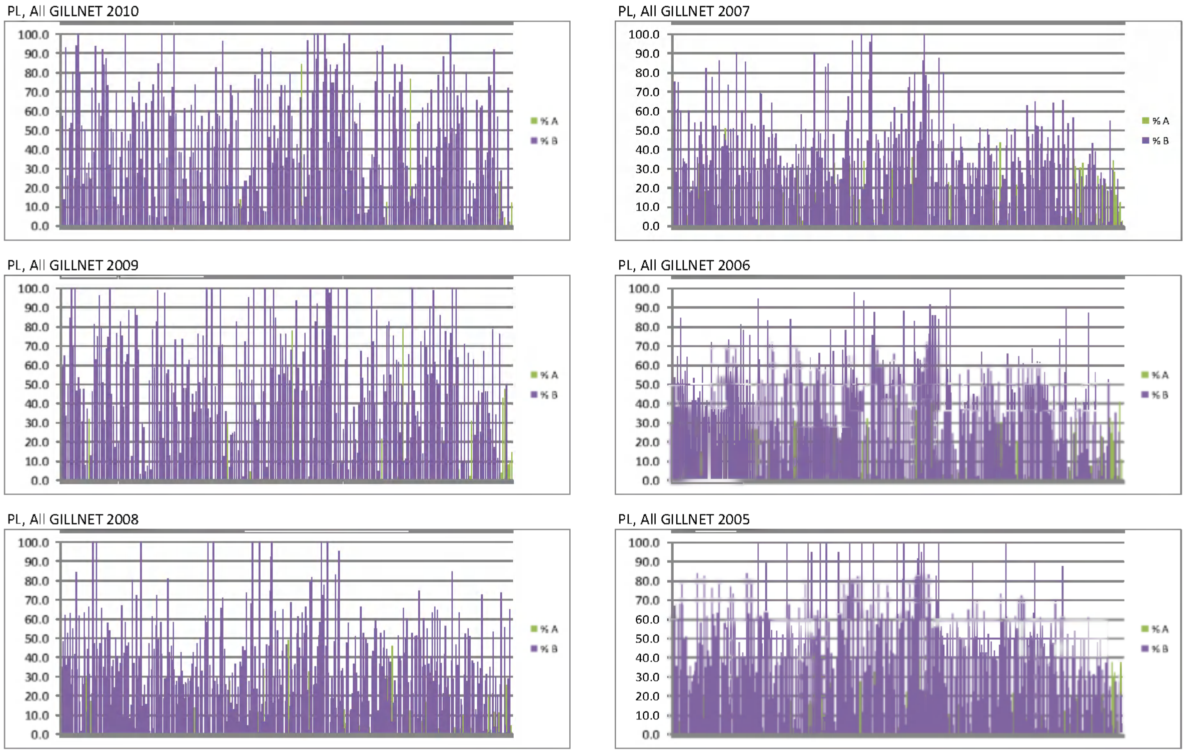


Figure 6.2 Percent effort quota (fishing days) uptake by gillnet vessels per year during the period 2005-2010 having quota in the Western Baltic Sea (Area A) and/or the Eastern Baltic Sea (Area B).

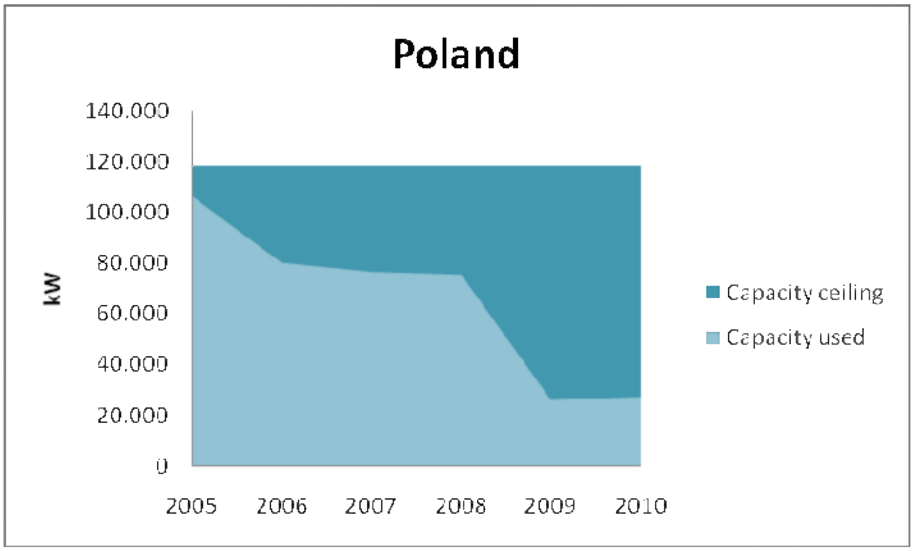


Effort limitations appear to have been restrictive to limited extent during the whole period 2005-2010 for Polish vessels, which is especially the case for gillnet vessels during the period 2005-2010 in the Eastern Baltic Sea. However, there is a tendency towards an increasing proportion of the effort quota is fully used over time especially for gillnet vessels in the Eastern Baltic Sea. In case of continued effort reductions according to the implementation of the management plan then the effort can be expected to be more restrictive for more vessels in the coming years. There seems not to have been restrictions according to effort quotas for Polish trawl gear and other gear vessels in any of the areas.

Table 6.3 Poland . National cod quota (TAC) by management area and quota uptake.

Country - POL	National quota				Quota uptake (landings)				Quota Uptake in %		
Management area	A	B	C	A+B+C	A	B	C	A+B+C	A	B	A+B+C
2005	1335	12053		13388	1073.3	11532	0	12605.3	80.4	95.7	94.2
2006	1685	14325		16010	799.7	14278.2	0	15077.9	47.5	99.7	94.2
2007	2287	12794		15081	2360.7	20790.4	0	23151.1	103.2	162.5	153.5
2008	1452	10694		12146	1385.4	7875.3	0	9260.7	95.4	73.6	76.2
2009	1009	10857		11866	527	10571.2	0	11098.2	52.2	97.4	93.5
2010	2087	11911		13998	725.8	11836.6	0	12562.4	34.8	99.4	89.7

Figure 6.3 Capacity ceiling in relation to capacity utilization for the Baltic Sea for the period 2005-2010



The capacity ceiling was established at 118.618 kW in 2005 according to the cod management plan. The capacity was utilised at 90% in that year. There had been a significant decline after the management plan had been enacted. The capacity utilisation decreased by 41.6%.

7.0 Estonia (EE): Results and conclusions

Table 7.1 Total effort summed by year for all Estonian vessels divided by fleet 2005-2010 for vessels fishing in the Western Baltic Sea (Area A) and the Eastern Baltic Sea (Area B)

	Year	Data										
	2005		2006		2007		2008		2009		2010	
Main Gear	Sum of A	Sum of B	Sum of A	Sum of B	Sum of A	Sum of B	Sum of A	Sum of B	Sum of A	Sum of B	Sum of A	Sum of B
GILL_110-156	137	580	165	530	81	390	170	192	187	144		
OTTER_>=105	6	175			0	103					8	211
PEL_TRAWL_>=105	3	119	0	245	3	263	0	316	0	155	0	78
PEL_TRAWL_16-31	0	0	0	0	0	0	0	0	0	0	0	0
Grand Total	146	874	165	775	84	756	170	508	187	299	8	289

Table 7.2 Total effort allowed and total effort used by Estonian vessel type and vessel length groups by year in the period 2005-2010

Country	ESTONIA											
TRAWL Fishery*	Western Baltic											
	8-10		10-12		12-18		18-24		24-40		>40	
	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used
2005									-	9		
2006									-	0		
2007									-	3		
2008									0	0		
2009									0	0		
2010									362	8		

Country	ESTONIA											
TRAWL Fishery*	Eastern Baltic											
	8-10		10-12		12-18		18-24		24-40		>40	
	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used
2005									-	294		
2006									-	245		
2007									-	366		
2008									1602	316		
2009									960	155		
2010									800	289		

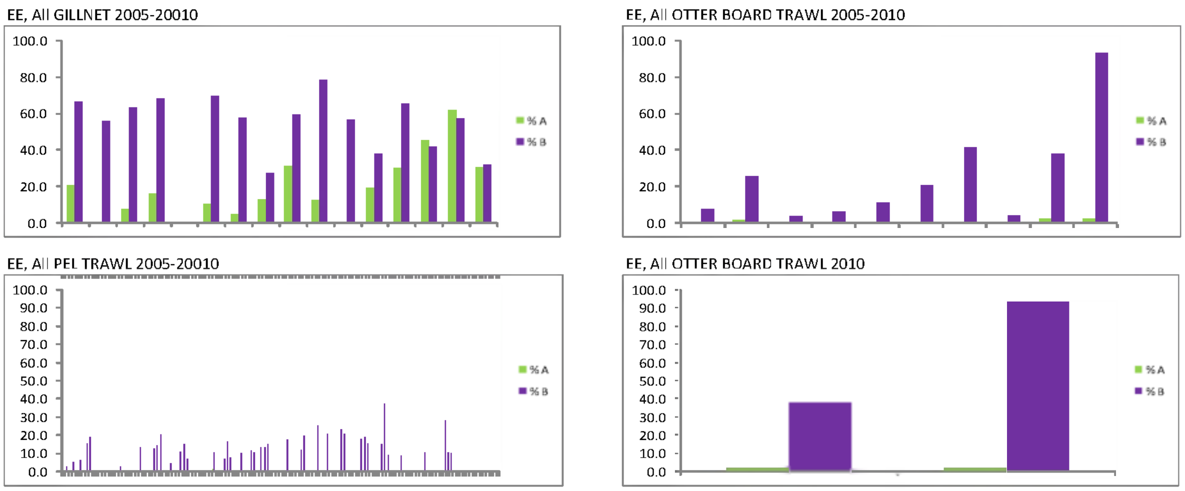
Table 7.3 Total effort allowed and total effort used by Estonian vessel type and vessel length groups by year in the period 2005-2010

Country	ESTONIA											
GILLNET Fishery**	Western Baltic											
	8-10		10-12		12-18		18-24		24-40		>40	
	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used
2005									-	137		
2006									-	165		
2007									-	81		
2008									446	170		
2009									402	187		
2010									0	0		

Country	ESTONIA											
GILLNET Fishery**	Eastern Baltic											
	8-10		10-12		12-18		18-24		24-40		>40	
	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used
2005									-	580		
2006									-	530		
2007									-	390		
2008									356	192		
2009									320	144		
2010									0	0		

There is no information available from Estonia on effort used by vessels less than 8 m in vessel length, i.e. not applicable for Estonia. There were no fishing permits of cod issued for vessels < 8 m. Catches of cod in Estonian small-scale fishery are very rare (whole catch below 4000 kg/year) and during any fishing operation does not exceed 50 kg.

Figure 7.1 Percent effort quota (fishing days) uptake by vessel for all years during the period 2005-2010 having quota in the Western Baltic Sea (Area A) and/or the Eastern Baltic Sea (Area B).

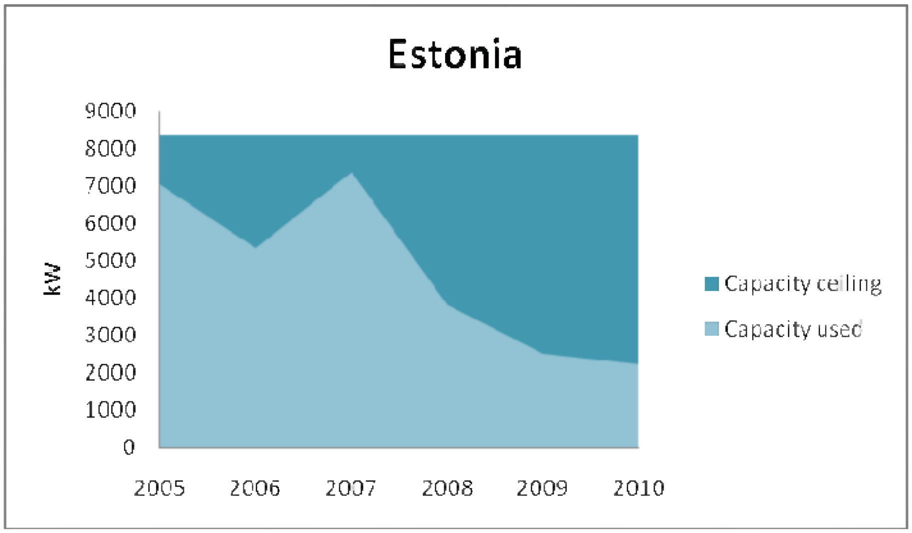


Effort limitations appear not to have been restrictive during the whole period 2005-2010 for any type of Estonian vessels, except maybe for one otter board trawl vessel in 2010 in the Eastern Baltic Sea. As such might be a tendency towards an increasing proportion of the effort quota is fully used over time. In case of continued effort reductions according to the implementation of the management plan then the effort can be expected to be more restrictive for more vessels in the coming years.

Table 7.4 Estonia . National cod quota (TAC) by management area and quota uptake.

ESTONIA									Quota Uptake in %		
Management area	A	B	C	A+B+C	A	B	C	A+B+C	A	B	A+B+C
2005	64	533		597	63	525	0	588.4	97.7	98.6	98.6
2006	160	861		1021	102	603	0	704.9	63.8	70.0	69.0
2007	174	888		1062	69	876	0	945.8	39.8	98.7	89.1
2008	135	836		971	132	839	2	972.5	98.0	100.3	100.2
2009	190	628		818	194	623	3	820.7	102.3	99.2	100.3
2010	135	817		952	0	793	3	796.1	0.3	97.0	83.6

Figure 7.2 Capacity ceiling in relation to capacity utilization for the Baltic Sea for the period 2005-2010



The capacity utilisation of Estonia increased between the years 2006 and 2007. In relation to the capacity ceiling, set in accordance to the cod management plan, the capacity utilisation has declined significantly in Estonia since the management plan had been established. It decreased by 61,4% between the years 2007-2010.

8.0 Latvia (LV): Results and conclusions

Table 8.1 Total effort summed by year for all Latvian vessels divided by fleet 2005-2010 for vessels fishing in the Western Baltic Sea (Area A) and the Eastern Baltic Sea (Area B)

	Column Labels											
	2005		2006		2007		2008		2009		2010	
Row Labels	Sum of A	Sum of B	Sum of A	Sum of B	Sum of A	Sum of B	Sum of A	Sum of B	Sum of A	Sum of B	Sum of A	Sum of B
GILL	1116	4513	1144	3424	150	3215	55	3030	12	2072	48	1850
OTTER	75	1200	6	1638	78	970		1050		844	36	894
PEL_TRAWL	5	757		22	9	383		19		39		
Grand Total	**1196**	**6470**	**1150**	**5084**	**237**	**4568**	**55**	**4099**	**12**	**2955**	**84**	**2744**

Table 8.2 Total effort allowed and total effort used by Latvian vessel type and vessel length groups by year in the period 2005-2010

Country	Latvia											
TRAWL Fishery	Western Baltic											
	8-10 Effort allowed	8-10 Effort used	10-12 Effort allowed	10-12 Effort used	12-18 Effort allowed	12-18 Effort used	18-24 Effort allowed	18-24 Effort used	24-40 Effort allowed	24-40 Effort used	>40 Effort allowed	>40 Effort used
2005										80		
2006										6		
2007										100		
2008												
2009												
2010										36		

Country	Latvia											
TRAWL Fishery	Eastern Baltic											
	8-10 Effort allowed	8-10 Effort used	10-12 Effort allowed	10-12 Effort used	12-18 Effort allowed	12-18 Effort used	18-24 Effort allowed	18-24 Effort used	24-40 Effort allowed	24-40 Effort used	>40 Effort allowed	>40 Effort used
2005										1011		
2006								43		1629		
2007								30		1418		
2008						5				1416		
2009										883		
2010								11		894		

Table 8.3 Total effort allowed and total effort used by Latvian vessel type and vessel length groups by year in the period 2005-2010

Country	Latvia											
GILLNET Fishery	Western Baltic											
	8-10 Effort allowed	8-10 Effort used	10-12 Effort allowed	10-12 Effort used	12-18 Effort allowed	12-18 Effort used	18-24 Effort allowed	18-24 Effort used	24-40 Effort allowed	24-40 Effort used	>40 Effort allowed	>40 Effort used
2005										1056		
2006										1130		
2007										161		
2008										55		
2009										12		
2010										48		

Country	Latvia											
GILLNET Fishery	Eastern Baltic											
	8-10 Effort allowed	8-10 Effort used	10-12 Effort allowed	10-12 Effort used	12-18 Effort allowed	12-18 Effort used	18-24 Effort allowed	18-24 Effort used	24-40 Effort allowed	24-40 Effort used	>40 Effort allowed	>40 Effort used
2005		307				26				4168		
2006		589								3377		
2007		442								3416		
2008		317								3380		
2009		286								2072		
2010		340								1850		

There is no information available from Latvia on effort used by vessels less than 8 m in vessel length, i.e. not applicable for Latvia.

Figure 8.1 Percent effort quota (fishing days) uptake by vessel for all years during the period 2005-2010 having quota in the Western Baltic Sea (Area A) and/or the Eastern Baltic Sea (Area B).

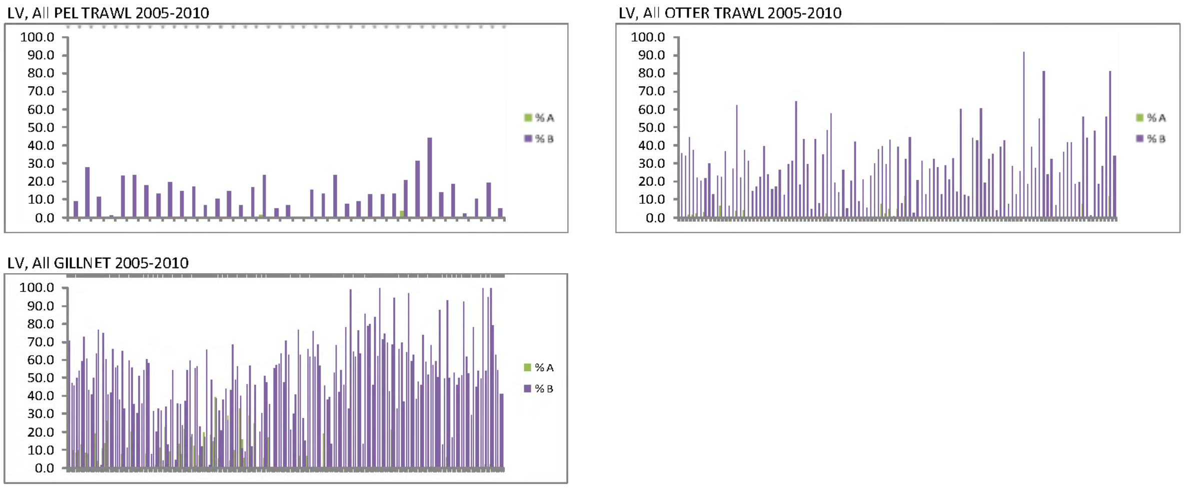
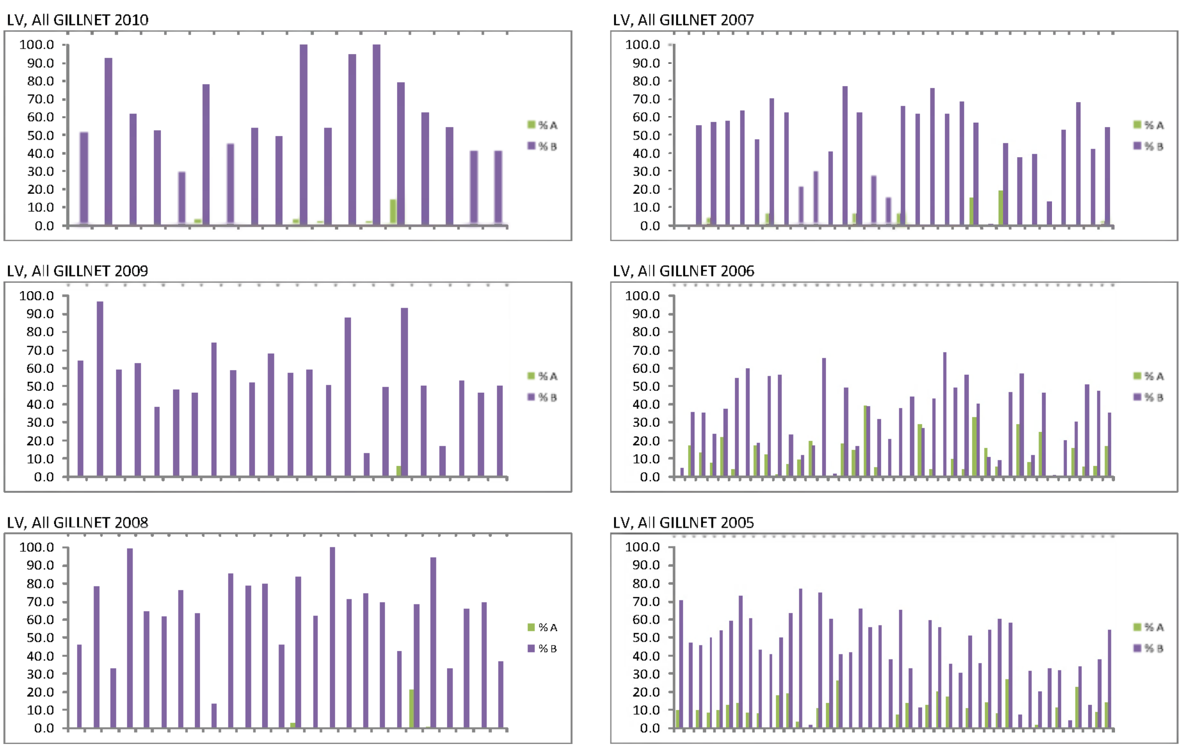


Figure 8.2 Percent effort quota (fishing days) uptake by gillnet vessels per year during the period 2005-2010 having quota in the Western Baltic Sea (Area A) and/or the Eastern Baltic Sea (Area B).



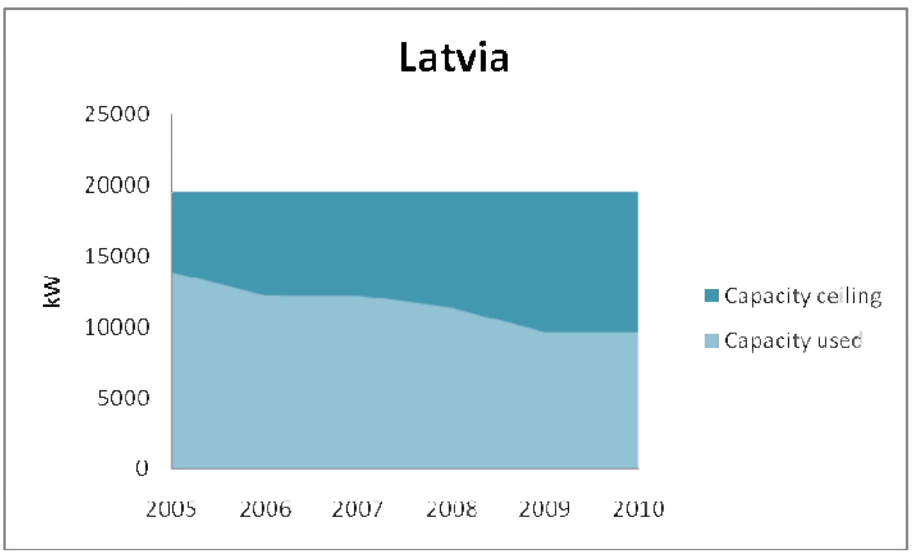
Effort limitations appear to have been restrictive to limited extent during the period 2008-2010 for Latvian vessels, which is especially the case for gillnet vessels during the period 2008-2010 in the

Eastern Baltic Sea. There is as such a tendency towards an increasing proportion of the effort quota is fully used over time especially for gillnet vessels in the Eastern Baltic Sea. In case of continued effort reductions according to the implementation of the management plan then the effort can be expected to be more restrictive for more vessels in the coming years. There seems not to have been restrictions according to effort quotas for Latvian trawl gear vessels in any of the areas.

Table 8.4 Latvia . National cod quota (TAC) by management area and quota uptake.

Country: Latvia	National quota				Quota uptake (landings)				Quota Uptake in %		
Management area	A	B	C	A+B+C	A	B	C	A+B+C	A	B	A+B+C
2005	522.0	3701.0	0.0	4223.0	471.3	3434.6	0.0	3905.9	90.3	92.8	92.5
2006	600.0	4299.0	0.0	4899.0	592.4	4039.1	0.0	4631.5	98.7	94.0	94.5
2007	392.0	4057.0	0.0	4449.0	262.9	4018.4	0.0	4281.3	67.1	99.0	96.2
2008	33.0	4072.0	0.0	4105.0	29.7	3970.1	0.0	3999.8	90.0	97.5	97.4
2009	29.0	4693.0	0.0	4722.0	22.8	4594.5	0.0	4617.3	78.6	97.9	97.8
2010	168.0	5159.9	0.0	5327.9	163.0	5004.6	0.0	5167.6	97.0	97.0	97.0

Figure 8.3 Capacity ceiling in relation to capacity utilization for the Baltic Sea for the period 2005-2010



In Latvia the capacity used only declined slightly between the years 2005- 2010. After the management plan had been enacted, the capacity used has shown a slight decrease of 13,3%.

9.0 Lithuania (LT): Results and conclusions

Table 9.1 Total effort summed by year for all Lithuanian vessels divided by fleet 2005-2010 for vessels fishing in the Western Baltic Sea (Area A) and the Eastern Baltic Sea (Area B)

	Year	Data										
	2005		2006		2007		2008		2009		2010	
Main Gear	Sum of A	Sum of B	Sum of A	Sum of B	Sum of A	Sum of B	Sum of A	Sum of B	Sum of A	Sum of B	Sum of A	Sum of B
GILL110-156	51	868	0	805	0	995	0	843	0	995	0	860
LONGLINE			0	345	0	232	0	120	0	6		
OTTER>=105	142	2907	29	2849	0	1856	0	1660	0	1389	0	1488
Grand Total	193	3775	29	3999	0	3083	0	2623	0	2390	0	2348

Table 9.2 Total effort allowed and total effort used by Latvian vessel type and vessel length groups by year in the period 2005-2010

Country	LITHUANIA											
TRAWL Fishery	Western Baltic											
	8-10		10-12		12-18		18-24		24-40		>40	
	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used
2005	0	0	0	0	0	0	304	0	11856	142	0	0
2006	0	0	0	0	0	0	274	0	10138	29	0	0
2007	0	0	0	0	0	0	0	0	0	0	0	0
2008	0	0	0	0	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0	0	0	0	0

Country	LITHUANIA											
TRAWL Fishery	Eastern Baltic											
	8-10		10-12		12-18		18-24		24-40		>40	
	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used
2005	0	0	0	0	0	0	227	0	8853	2892	0	0
2006	0	0	0	0	0	0	246	0	9102	2784	0	0
2007	0	0	0	0	0	0	222	0	7548	1856	0	0
2008	0	0	0	0	0	0	178	0	5162	1660	0	0
2009	0	0	0	0	0	0	160	0	3840	1389	0	0
2010	0	0	0	0	0	0	160	0	4000	1488	0	0

Table 9.3 Total effort allowed and total effort used by Latvian vessel type and vessel length groups by year in the period 2005-2010

Country	LITHUANIA											
GILLNET Fishery	Western Baltic											
	8-10		10-12		12-18		18-24		24-40		>40	
	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used
2005	0	0	0	0	0	0	304	0	2432	0	0	0
2006	0	0	0	0	0	0	274	0	2192	0	0	0
2007	0	0	0	0	0	0	0	0	0	0	0	0
2008	0	0	0	0	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0	0	0	0	0

Country	LITHUANIA											
GILLNET Fishery	Eastern Baltic											
	8-10		10-12		12-18		18-24		24-40		>40	
	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used
2005	2270	0	2270	18	1589	0	227	89	1816	732	0	0
2006	492	30	1476	183	738	0	246	67	1968	489	0	0
2007	888	104	1554	313	444	68	222	6	888	373	0	0
2008	712	111	1246	239	712	69	178	0	534	368	0	0
2009	480	141	1440	279	640	65	160	0	480	459	0	0
2010	320	0	1280	291	320	8	160	0	480	522	0	0

Table 9.4 Total effort allowed and total effort used by Latvian vessel type and vessel length groups by year in the period 2005-2010

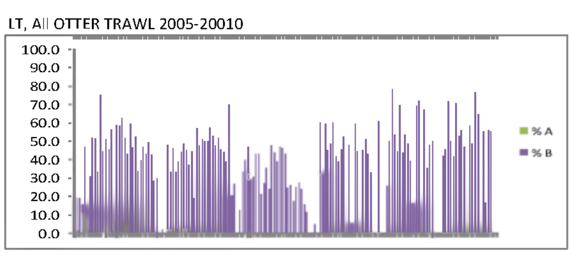
Country	LITHUANIA											
OTHER Fishery	Western Baltic											
	8-10		10-12		12-18		18-24		24-40		>40	
	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used
2005	0	0	0	0	0	0	304	0	2432	51	0	0
2006	0	0	0	0	0	0	274	0	2192	0	0	0
2007	0	0	0	0	0	0	0	0	0	0	0	0
2008	0	0	0	0	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0	0	0	0	0

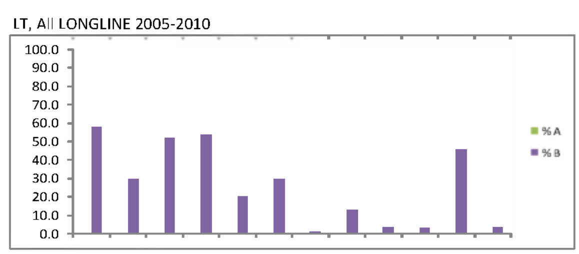
Country	LITHUANIA											
OTHER Fishery	Eastern Baltic											
	8-10		10-12		12-18		18-24		24-40		>40	
	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used
2005	2270	0	2270	0	1589	0	227	26	1816	44	0	0
2006	492	15	1476	2	738	3	246	76	1968	248	0	0
2007	888	98	1554	48	444	25	222	40	888	153	0	0
2008	712	2	1246	70	712	38	178	0	534	58	0	0
2009	480	0	1440	51	640	20	160	0	480	0	0	0
2010	320	0	1280	39	320	0	160	0	480	0	0	0

Table 9.5 Effort used for Polish vessels < 8 m vessel length.

Country	Western Baltic		Eastern Baltic		Eastern+Western Baltic	
	Effort allowed	Effort used	Effort allowed	Effort used	Effort allowed	Effort used
2005	0	0	18841	3022	18841	3022
2006	0	0	18450	2126	17450	2126
2007	-	-	-	-	-	-
2008	-	-	-	-	-	-
2009	-	-	-	-	-	-
2010	-	-	-	-	-	-

Figure 9.1 Percent effort quota (fishing days) uptake by vessel for all years during the period 2005-2010 having quota in the Western Baltic Sea (Area A) and/or the Eastern Baltic Sea (Area B).





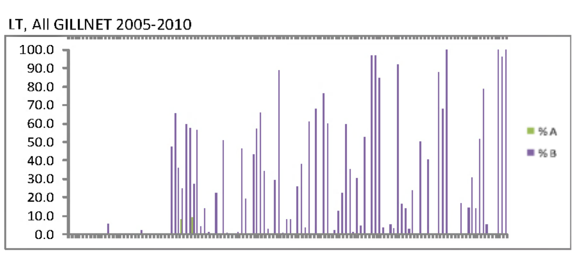
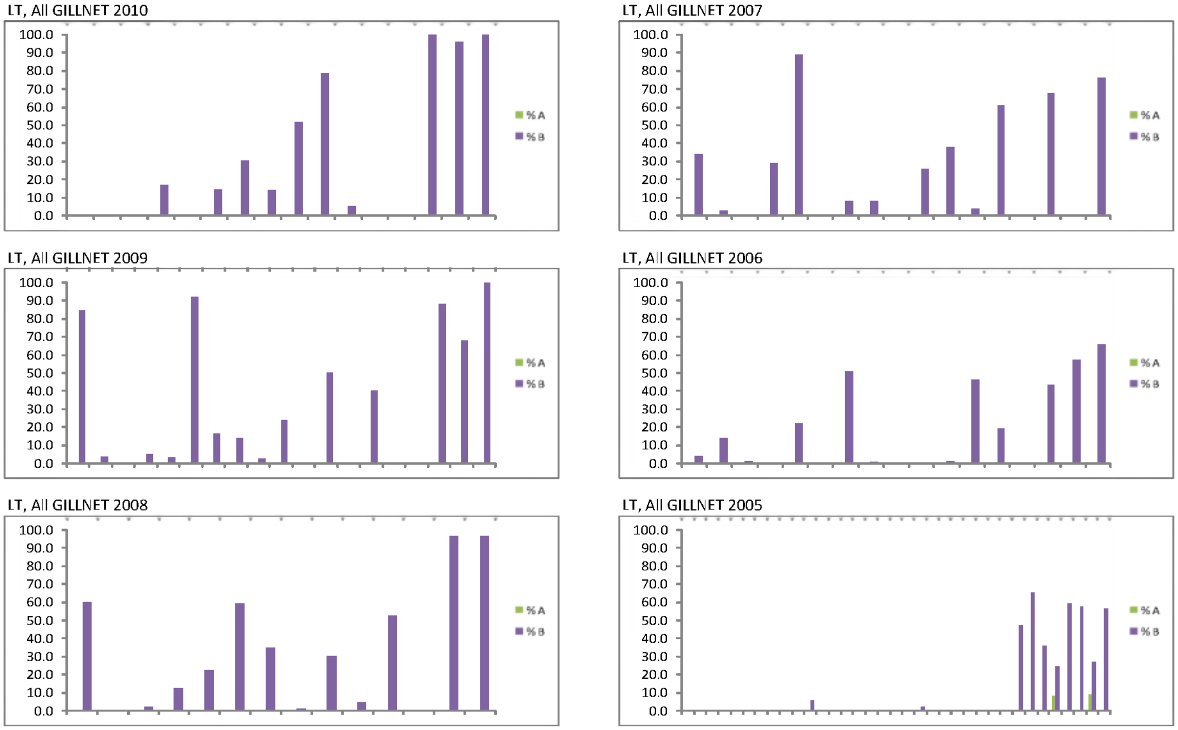


Figure 9.2 Percent effort quota (fishing days) uptake by gillnet vessels per year during the period 2005-2010 having quota in the Western Baltic Sea (Area A) and/or the Eastern Baltic Sea (Area B).

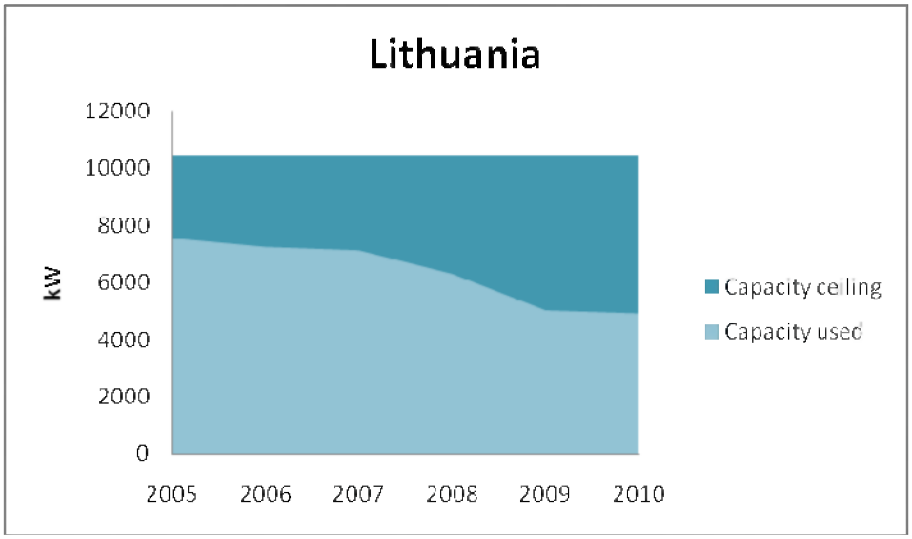


Effort limitations appear to have been restrictive to limited extent during the period 2008-2010 for Lithuanian vessels, which is especially the case for gillnet vessels during the period 2008-2010 in the Eastern Baltic Sea. There is as such a tendency towards an increasing proportion of the effort quota is fully used over time especially for gillnet vessels in the Eastern Baltic Sea. In case of continued effort reductions according to the implementation of the management plan then the effort can be expected to be more restrictive for more vessels in the coming years. There seems not to have been restrictions according to effort quotas for Lithuanian trawl and longline gear vessels in any of the areas.

Table 9.4 Lithuania . National cod quota (TAC) by management area and quota uptake.

Country: LTU	National quota				Quota uptake				Quota Uptake in %		
Management area	A	B	C	A+B+C	A	B	C	A+B+C	A	B	A+B+C
2005	145	2853		2998	144	2844	0	2988	99.3	99.7	99.7
2006	120	3265		3385	42	3259	0	3301	35.0	99.8	97.5
2007	0	2961		2961	0	2931	0	2931		99.0	99.0
2008	0	2631		2631	0	2613	0	2613		99.3	99.3
2009	0	2892		2892	0	2818	0	2818		97.4	97.4
2010	0	3300		3300	0	3197	0	3197		96.9	96.9

Figure 9.3 Capacity ceiling in relation to capacity utilization for the Baltic Sea for the period 2005-2010

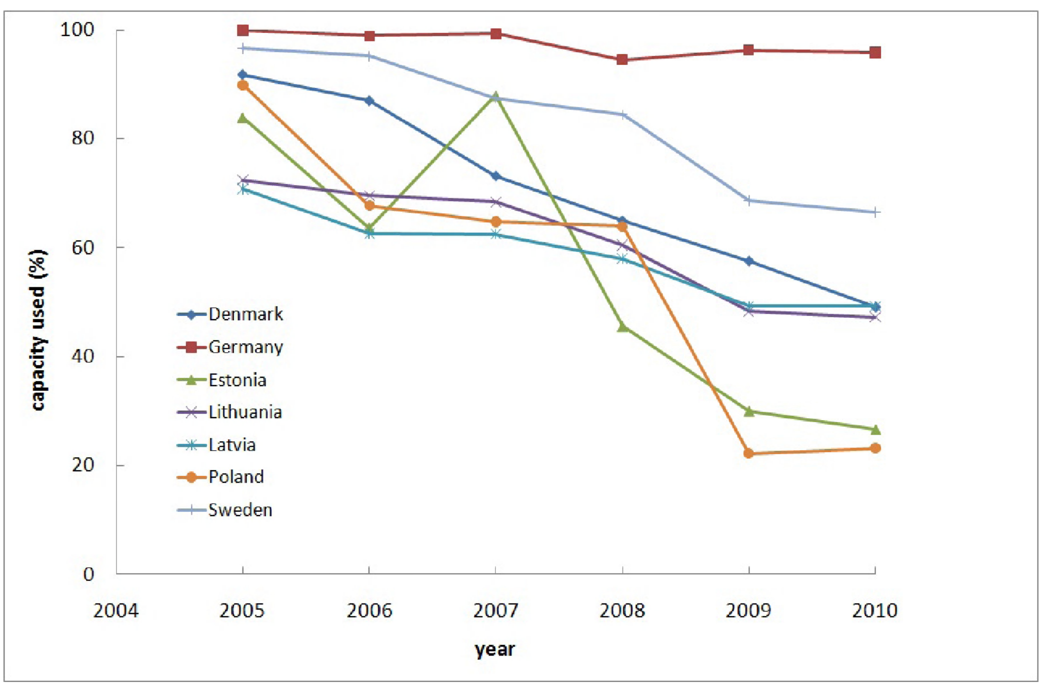


In accordance with article 10 (2) of Council Regulation 1098/2007, taking the year 2005 as reference year, the capacity ceiling for Lithuania was set at 10458 kW. Its capacity was not fully utilized during the reference period. After the management plan had been enacted, the capacity utilization exhibited a ecline of 21,2%.

10.0 Summary plots and tables of capacity, TAC, and effort utilization in the international Baltic cod fisheries

Capacity utilization

Figure 10.1 Capacity utilization for the Baltic Sea in international comparison for the period 2005-2010



In comparison, Estonia indicates a major loss of capacity used in the Baltic Sea fisheries, followed by Poland. Also Denmark indicates a significant decline of capacity used, as well as Sweden and Lithuania. The only member state which capacity is almost fully utilised in the period 2005-2010 is Germany. Latvia exhibits slight decline after the management plan had been established.

With respect to observed changes in capacity utilization according to the introduction of the Baltic cod management plan there can be observed some tendencies. Even the data may not be fully comparable between countries because there is variability between countries in the methods used on how capacity and capacity utilization has been estimated, there seems to be a tendency for Estonia and Poland of a significant decrease in capacity utilization from 2007/2008 to 2009 (when the management plan was introduced and enforced) to a lower level which have been consistently maintained in 2010.

In autumn 2007, a new government was elected in Poland. Within a month, the new government announced it would accept closures of eastern cod fishery by EC and after negotiation with the Commission developed a payback scheme to compensate illegal activities in the past. Following this agreement the government strengthened fisheries inspection services and developed fleet restructuring plan accepted by European Commission. These measures as well as others applied by Baltic States as the result of Copenhagen Declaration reduced the illegal overfishing from the Eastern cod stock to less than 10% (most recent estimate by the ICES WGBFAS is less than 6%) (EU STECF SGMOS-10-06b).

Table 10.1 Capacity utilization for the Baltic Sea in international comparison for the period 2005-2010

COUNTRY	YEAR	Capacity ceiling (kW)	Capacity used (kW)	Permits granted	Changes of used capacity (%) 2007-2010
Germany	2005	47.210	47.210	375	
	2006	47.210	46.704	369	
	2007	47.210	46.883	365	
	2008	47.210	44.638	354	
	2009	47.210	45.465	349	
	2010	47.210	45.262	346	3,4
Denmark	2005	89520	82.163	710	
	2006	89520	77.899	687	
	2007	89520	65.535	557	
	2008	89520	58.145	499	
	2009	89520	51559	446	
	2010	89520	43964	395	24,1
Estonia	2005	8393	7047	27	
	2006	8393	5345	20	
	2007	8393	7384	24	
	2008	8393	3825	15	
	2009	8393	2518	8	
	2010	8393	2234	5	61,4
Lithuania	2005	10458	7581	67	
	2006	10458	7275	49	
	2007	10458	7154	48	
	2008	10458	6327	45	
	2009	10458	5047	41	
	2010	10458	4941	38	21,2
Latvia	2005	19556	13853	116	
	2006	19556	12246	107	
	2007	19556	12221	100	
	2008	19556	11341	90	
	2009	19556	9627	75	
	2010	19556	9627	71	13,3
Poland	2005	118618	106697	926	
	2006	118618	80397	677	
	2007	118618	76832	636	
	2008	118618	75801	664	
	2009	118618	26348	357	
	2010	118618	27538	390	41,6
Sweden	2005	62450	60357	369	
	2006	62450	59445	358	
	2007	62450	54657	315	
	2008	62450	52734	299	
	2009	62450	42905	283	
	2010	62450	41532	260	21,0

Figure 10.2 Summary of fishing permits and active number of vessels in the international Baltic cod fishery during the period 2005-2010 (all member states).

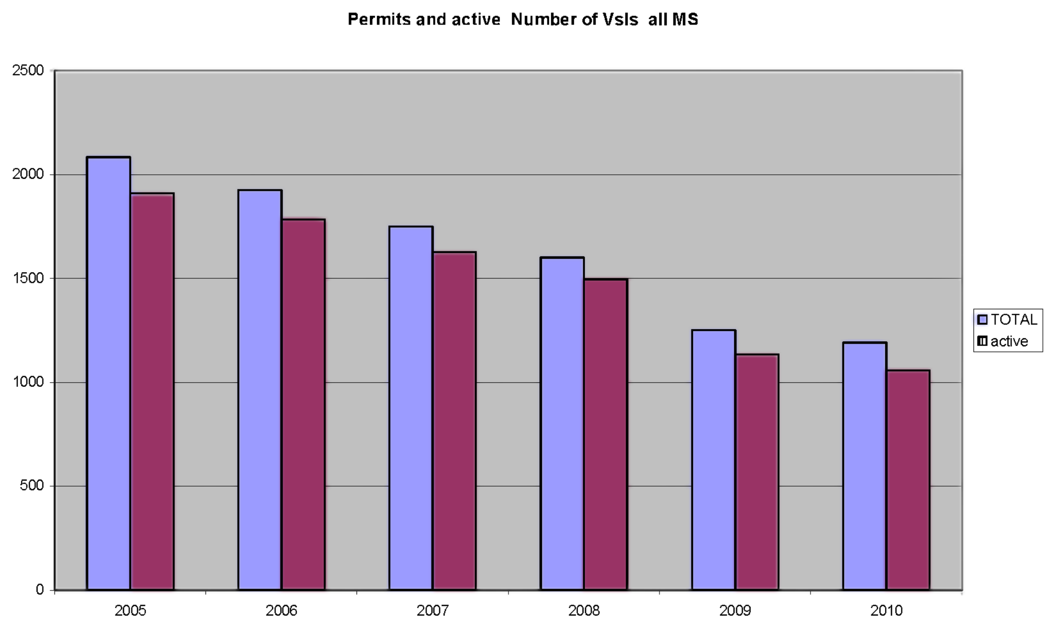
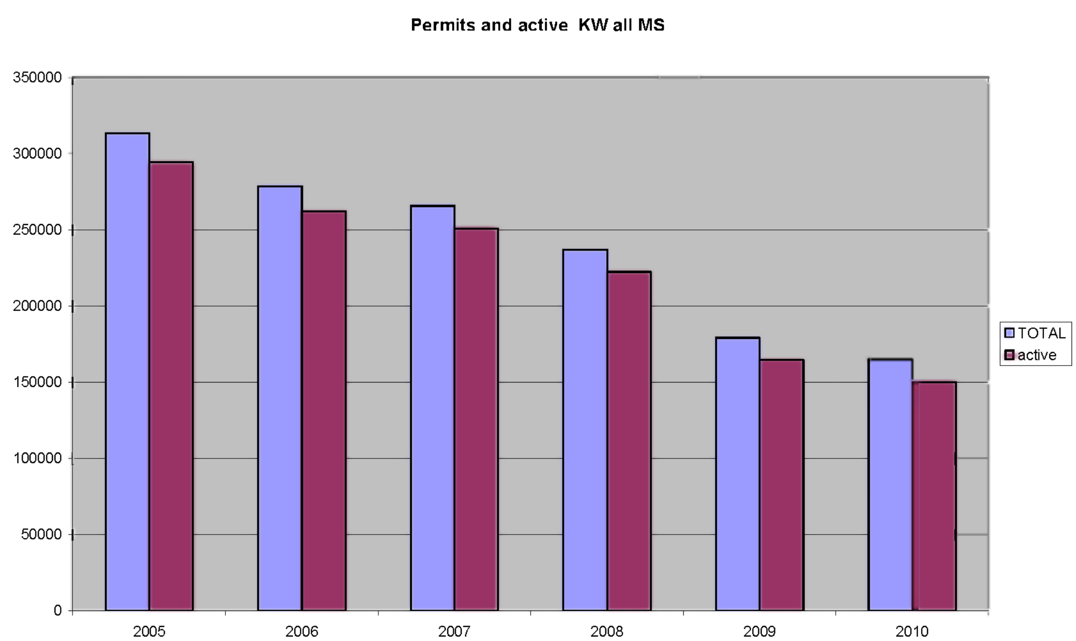


Figure 10.2 Summary of fishing permits and active kW in the international Baltic cod fishery during the period 2005-2010 (all member states).

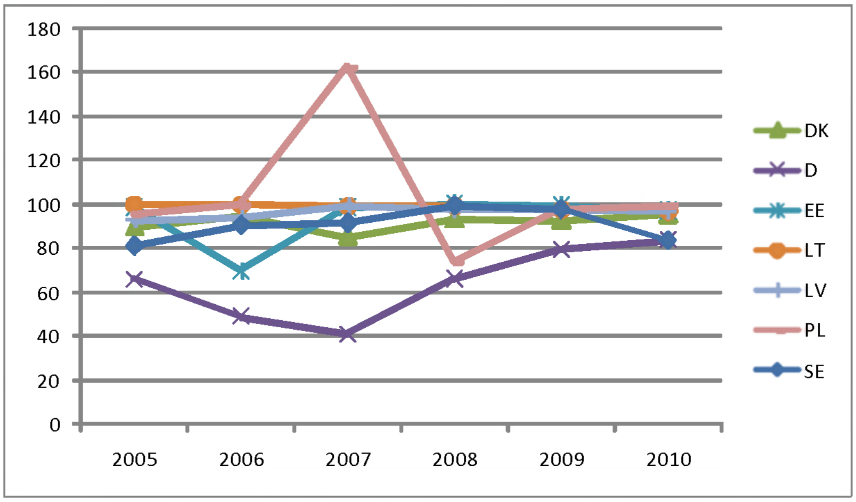


TAC Quota Uptake and Utilization

According to the data delivered by the national administrations as provided under the data call associated to EU STECF EWG-11-07 Baltic cod management plan evaluations (described in section 1-

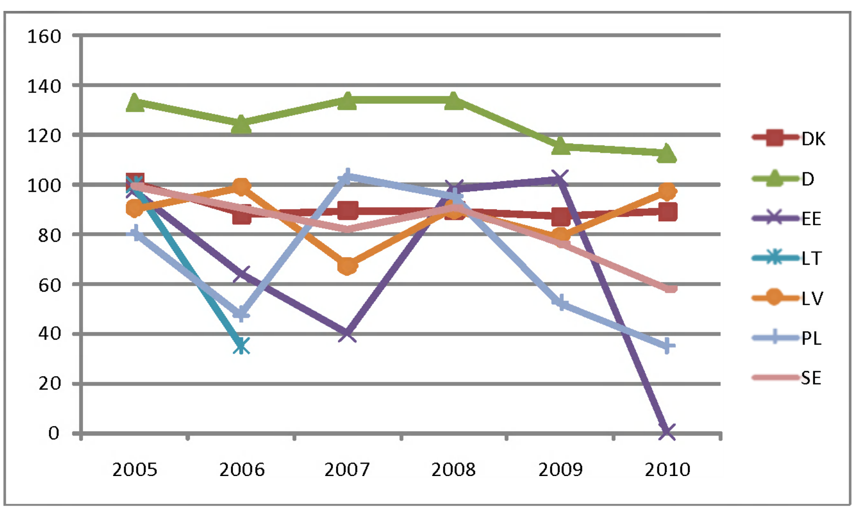
2) there can be observed some general trends. However, the background for the degree of TAC utilization can be very diverse according to year and country, and lack of full utilization does not necessarily mean that TACs have not been restrictive, which is important to note. Consequently, the data should be used with caution, and the data can be interpreted in several different ways.

Figure 10.3 Eastern Baltic Sea TAC Utilization by country during the period 2005-2010 according to the data call made in relation to among other the EU STECF EWG-11-07.



For the Eastern Baltic Sea the national cod TACs are in general fully utilized for most countries during the period 2005-2010, and in one case overshot. Only Germany seems not to have fully used its cod quota in the Eastern Baltic Sea especially in the early years of the period, but there is an increasing German utilization being more than 80% in 2010. No tendencies in TAC utilization according to implementation of the Baltic cod management plan (introduced from 2007-2008 onwards) can be observed for any countries.

Figure 10.4 Western Baltic Sea TAC Utilization by country during the period 2005-2010 according to the data call made in relation to among other the EU STECF EWG-11-07.



For the Western Baltic stock the TAC utilization is more variable among countries and years during the period 2005-2010. The TAC uptake is for certain countries consistently around 100% or even above 100% during the whole period, e.g. DK, D, and LV, while for S there has in the latest year (2010) been a significant decrease from a previous similar level. The quota uptake by PL varies over the years, and there is observed low levels in most recent years. It is not possible to detect any clear trends or changes in quota uptake according to introduction of the LTMP.

There can be several reasons for either not using fully or overshooting the TAC for a given year by a country. Some of the reasons can be transfer of TAC between years for at given country, exchange of TAC between countries, individual transferable quota system where certain vessels do not fully use their individual quota share, internal national TAC distribution schemes over the year preventing use of the last part of the TAC in the last part of the year e.g. because of unfortunate weather conditions for fishery here, local variability in the resource availability in relation to fishing localities used by the fishermen for a certain country, etc. In general, the TAC constraints under the LTMP are evaluated to have been restrictive, efficient and complied with both for the Eastern and Western Baltic cod fishery.

Effort quota utilization in the International Baltic cod fisheries

Figure 10.3 Summary of fishing effort utilization rate in percentage by main gear and management area in the international Baltic cod fishery during the period 2005-2010 (all member states).

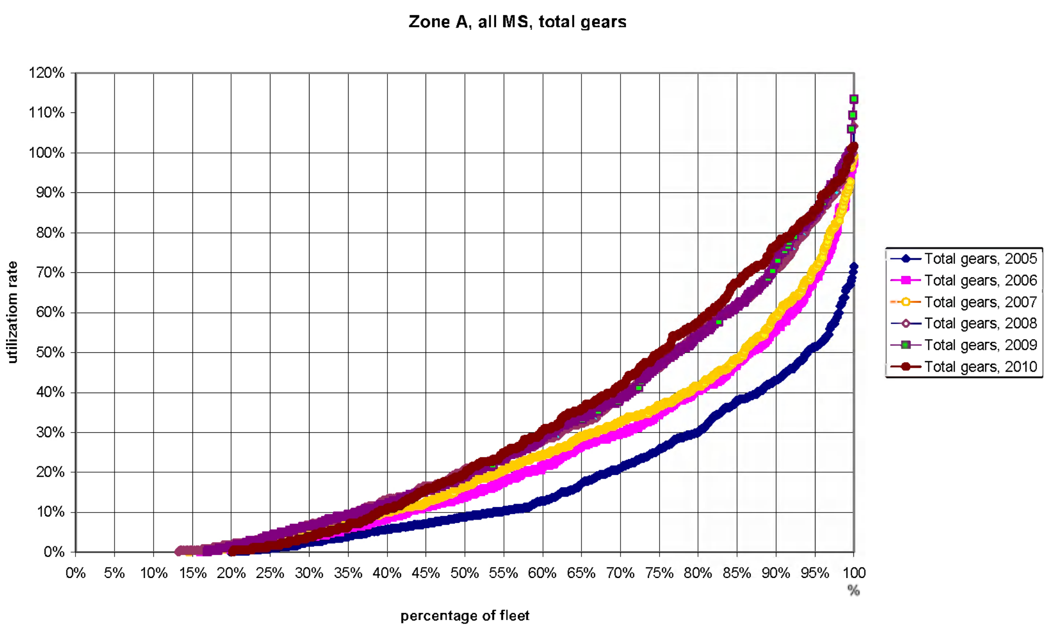


Figure 10.3 (continued).

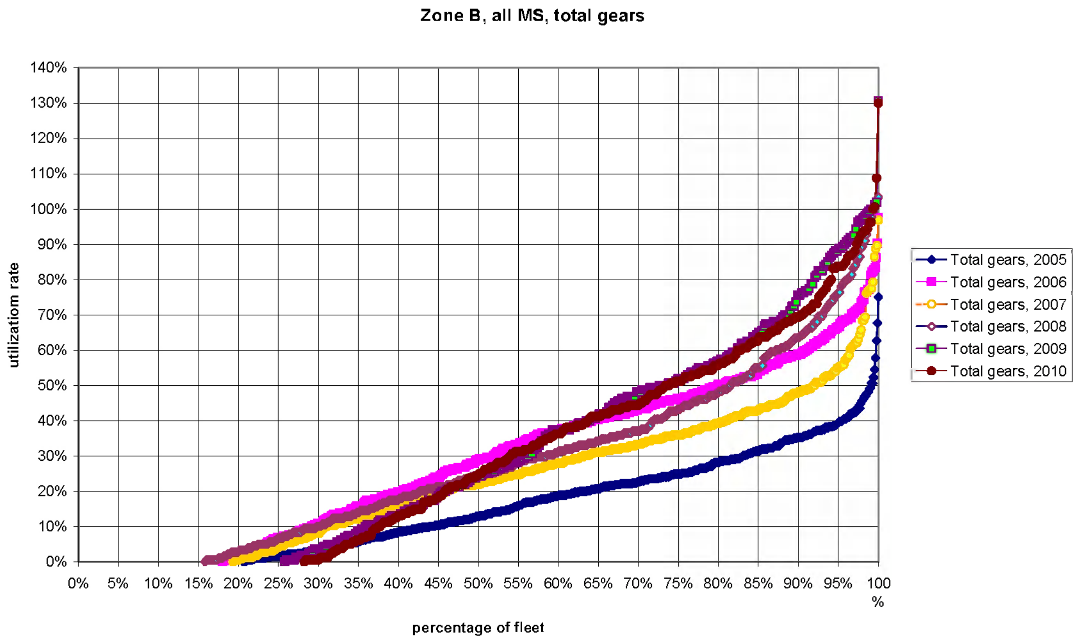


Figure 10.3 (continued)

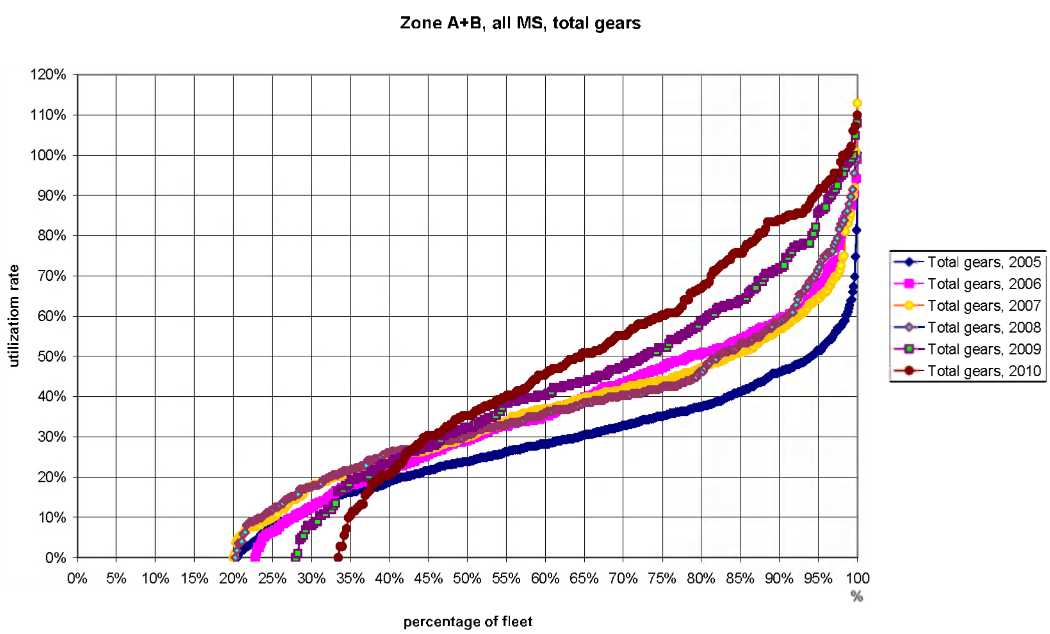


Figure 10.4 Summary of fishing effort utilization rate in percentage for active gears (and active vessels) by management area in the international Baltic cod fishery during the period 2005-2010 (all member states).

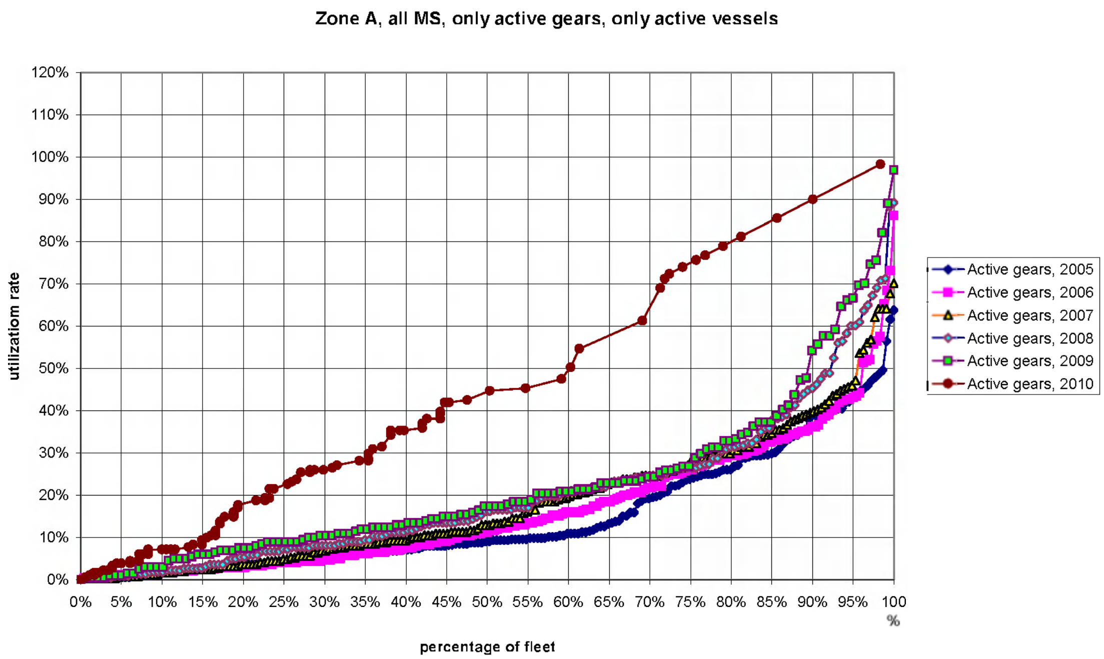
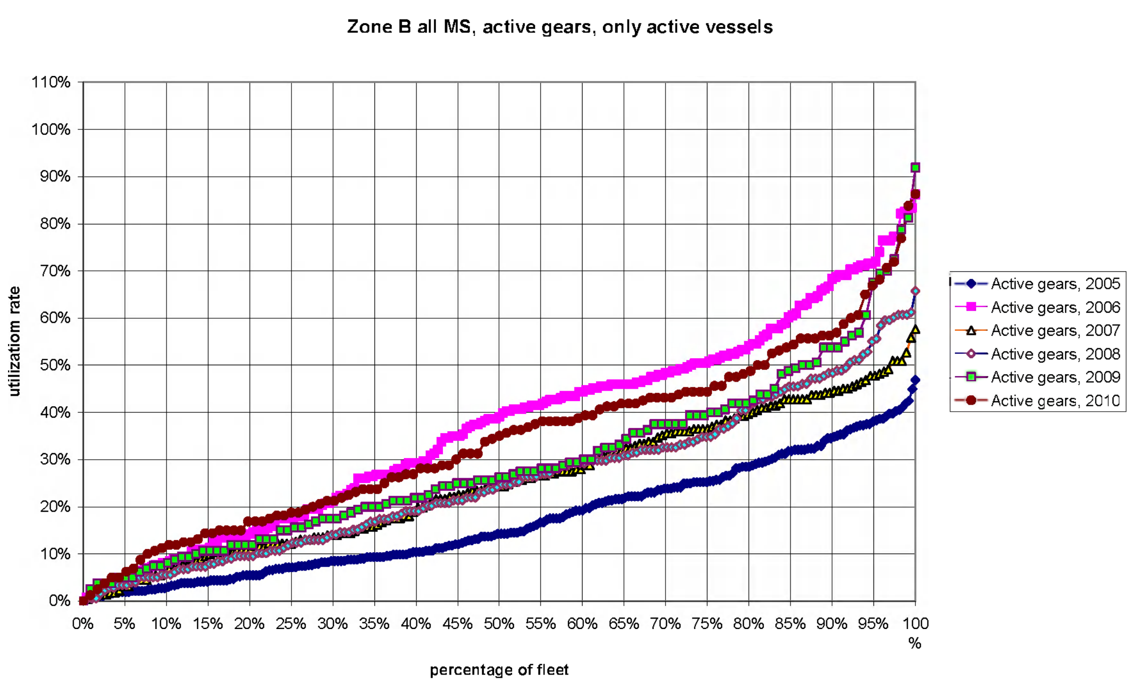


Figure 10.4 (Continued)



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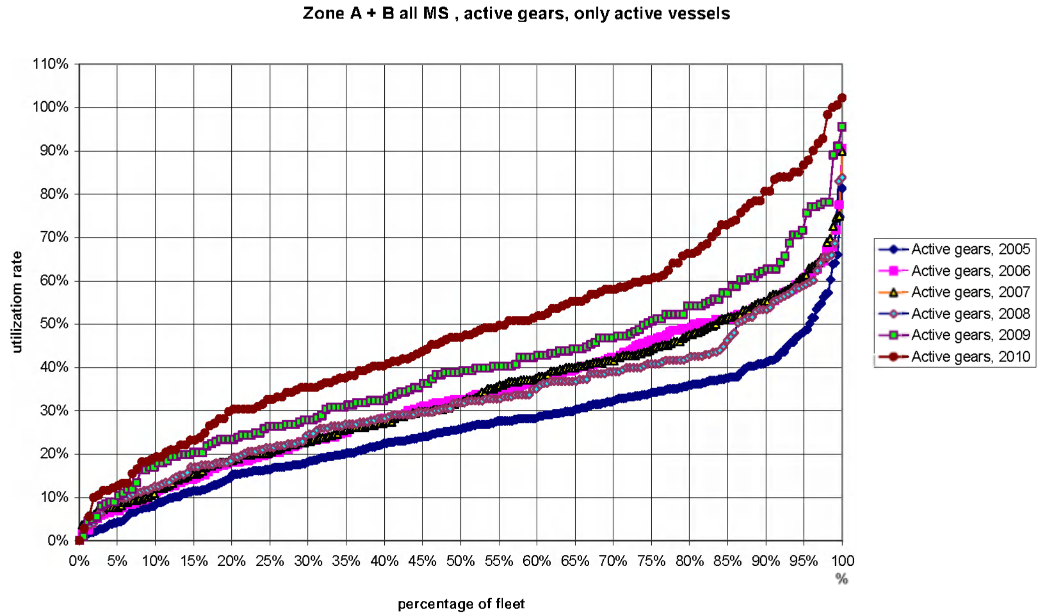


Figure 10.5 Summary of fishing effort utilization rate in percentage for passive gears (active vessels) by management area in the international Baltic cod fishery during the period 2005-2010 (all member states).

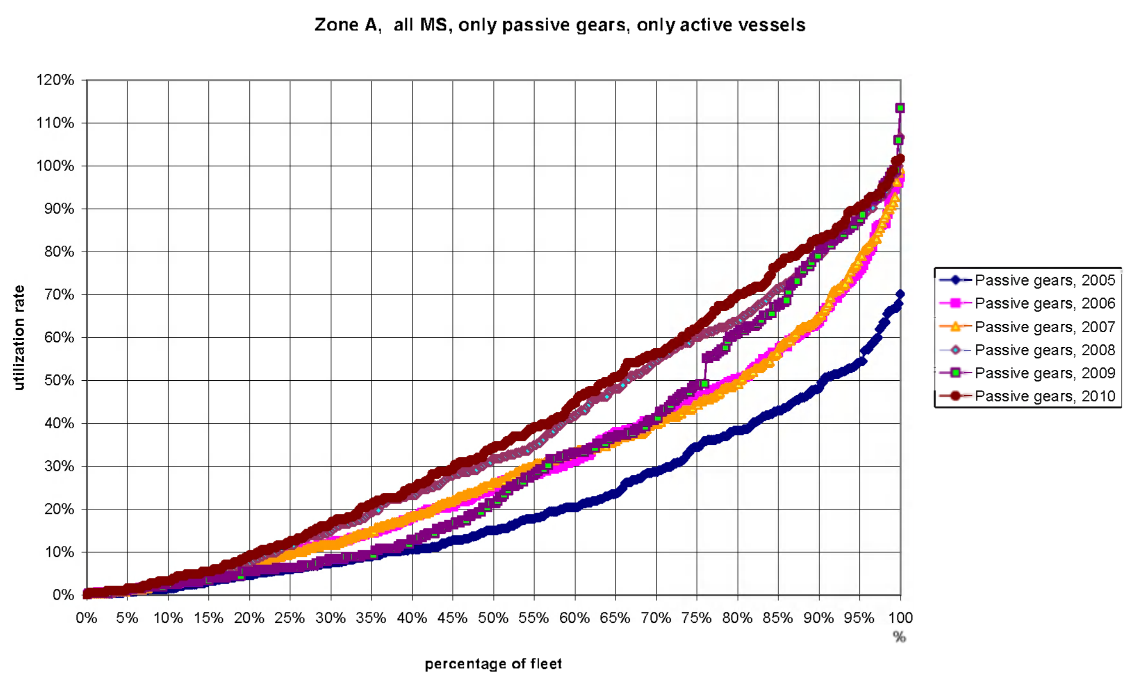


Figure 10.5 (Continued)

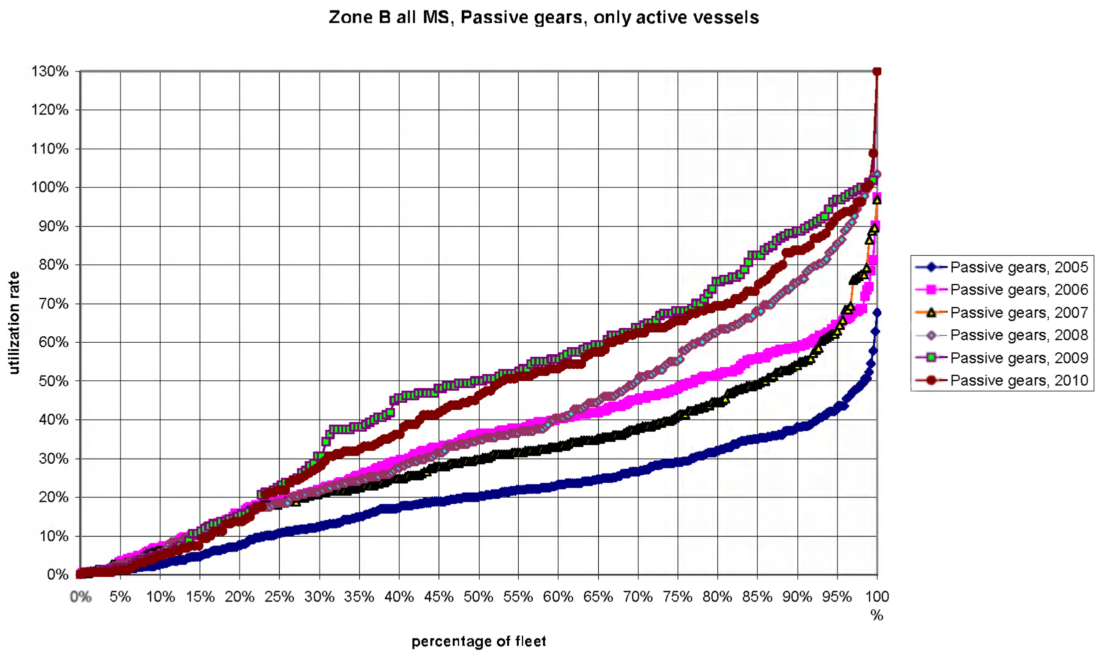
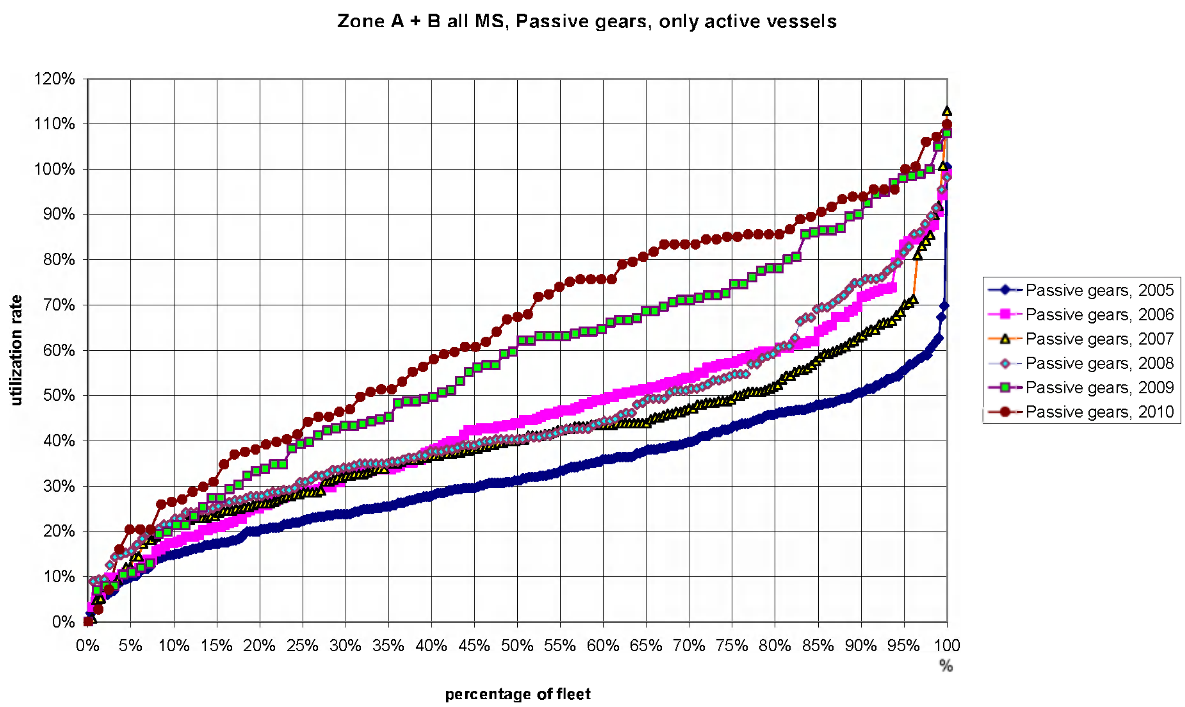


Figure 10.5 (Continued)



See overall conclusions under Sections 11.3 and 12.3 in relation to the effort quota utilization also summarizing the conclusions on this from sections 2-9.

11.0 Correlation analysis between different Effort Measures in the Baltic cod fishery

11.1 Introduction, purpose and materials and methods

The efficiency of the management plan in relation to the intentions (see e.g. the EU STECF SGMOS-10-6, Simmonds *et al.*, 2010) can also be evaluated according to whether there is an efficient F reduction when F is translated into E reduction given a Baltic stock is above F-targets. In this respect it is first of all relevant to evaluate the consistency and efficiency of different effort measures.

Are days absent from harbor and adequate measure for different fleet types? This question is among other relevant according to potential fishing power differences between different fleets and fisheries and un-even relationships between actual fishing time compared to steam time and total trip length for different fleets and fisheries.

In this respect, among other fisheries with passive gears compared to active gears should be considered and fisheries with relative long steaming time compared to actual fishing time.

One aim is to compare efficiency of effort (and capacity) measures (e.g kWd, days absent from harbor, other fishing activity measures) among other with respect to potential developments in fishing power, i.e. in the relationship between fishing mortality, F, and fishing effort, E (section 12).

Another central question in relation to consistency among effort measures in relation to the LTMP is whether the results of use of different estimation methods of effort are consistent (section 11). Is for example the method of estimating the initially allocated effort to the vessels and the method for actually accounting effort to vessel according to the effort quota given through the management plan consistent?

In order to address these questions there have been made different investigations using data on different aggregation levels. For Danish vessels there have been made investigations on consistency between different effort measures (days-at-sea, calendar-days and kWdays) using disaggregated data on trip level by fishery (métier) for both the Western and Eastern Baltic Sea fisheries, i.e. at the dis-aggregation level of fishing trips. Furthermore, national fishery data with two different effort measures (days at sea and kWdays) on an aggregated basis by year and fleet/fishery for the period 2005-2010 have been made available to the EU STECF EWG group from the EU STECF SGMOS-11-06 and consistency between measures have been investigated for the Danish, German and Swedish fisheries in the Western Baltic Sea (updating information from EU STECF SGMOS-09-05 and EU STECF SGMOS-10-05).

The disaggregated Danish data comprise different effort measures on fishing days at trip level as well as on kWdays level. The two fishing days at trip measures are defined by:

Calendar days = no of calendar days at sea (for each date registered in the full trip length)

Days at sea = (arrival time – departure time) / 24

The first measure is used on EU level to initially allocate number of fishing days to the vessels according to the EU effort quotas, while the latter method typically is used by the national Fisheries Directorates to account used effort in fishing days according to the quota, i.e. according to enforcement of restrictions according to the management plan.

11.2 Results

Below are given the results of preliminary correlation analyses between different effort measures for Danish fisheries using data on a trip disaggregation level. First, there are presented correlation plots for days-at-sea and calendar-days for main Danish fisheries (métiers) at trip level covering the fishery in 2010 in both the Eastern (SD 25-32) and the Western (SD 22-24) Baltic Sea. Secondly, there are presented correlation plots for days-at-sea versus kWdays on similar disaggregated level for the Danish fisheries in 2010.

Finally, there is presented correlation plots using aggregated data from the SGMOS-11-06 by year and fleet/fishery for the period 2005-2010 investigating consistency between days-at-sea and kWdays effort measures on aggregated basis for the Danish, German and Swedish fisheries in the Western Baltic Sea.

The effort measure in kWdays is days-at-sea divided by engine capacity (kW) by vessel, and the difference in correlation between the effort measures days-at-sea and kWdays on trip basis reflects the spread in engine kW within the group (fleet or fishery).

Figure 11.1 Correlation between effort in days-at-sea versus calendar days for selected main Danish Baltic cod fisheries by area in 2010. Gillnet metier Western Baltic Sea.

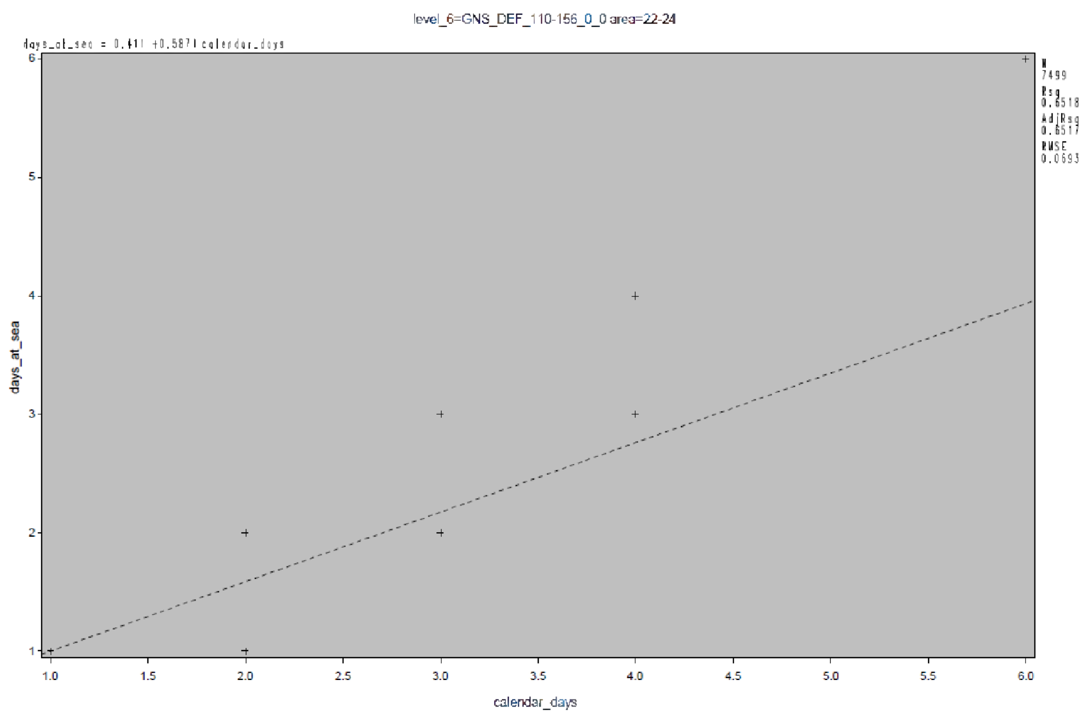


Figure 11.2 Correlation between effort in days-at-sea versus calendar days for selected main Danish Baltic cod fisheries by area in 2010. Gillnet métier Western Baltic Sea.

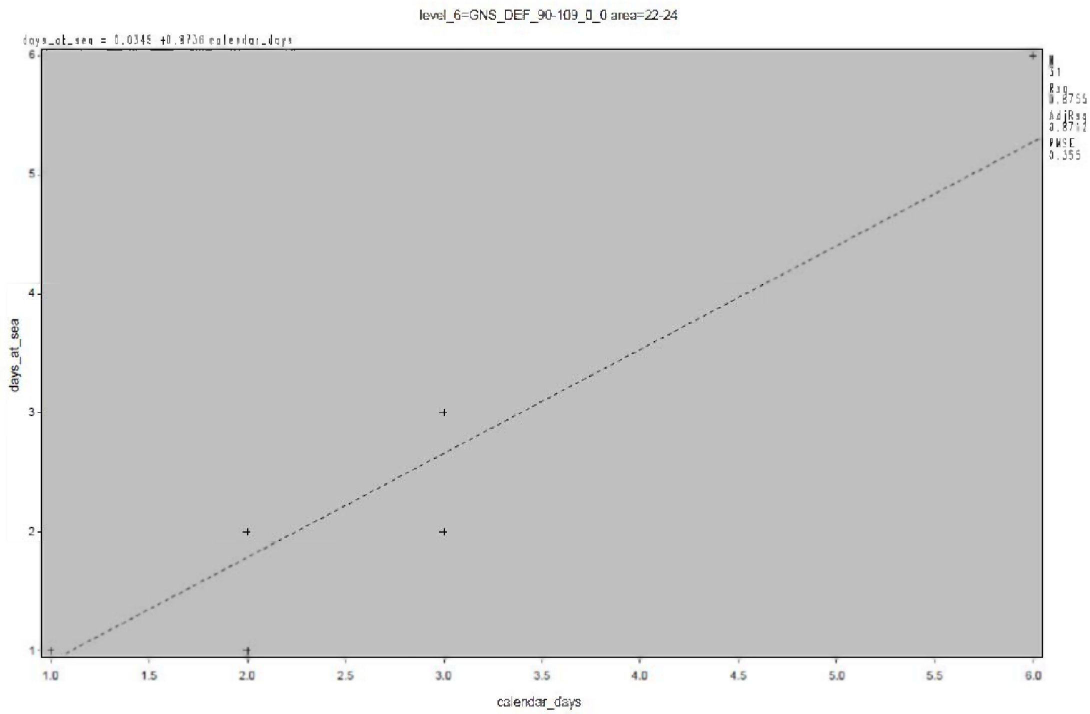


Figure 11.3 Correlation between effort in days-at-sea versus calendar days for selected main Danish Baltic cod fisheries by area in 2010. Gillnet métier Western Baltic Sea.

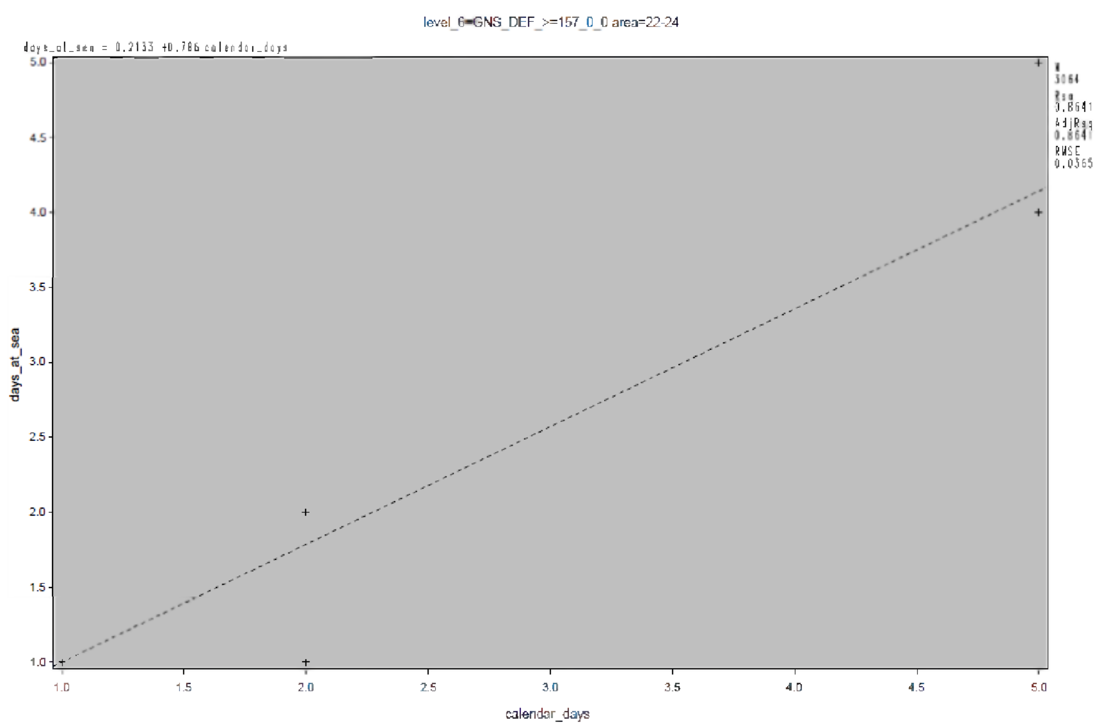


Figure 11.4 Correlation between effort in days-at-sea versus calendar days for selected main Danish Baltic cod fisheries by area in 2010. Demersal trawl metier Western Baltic Sea.

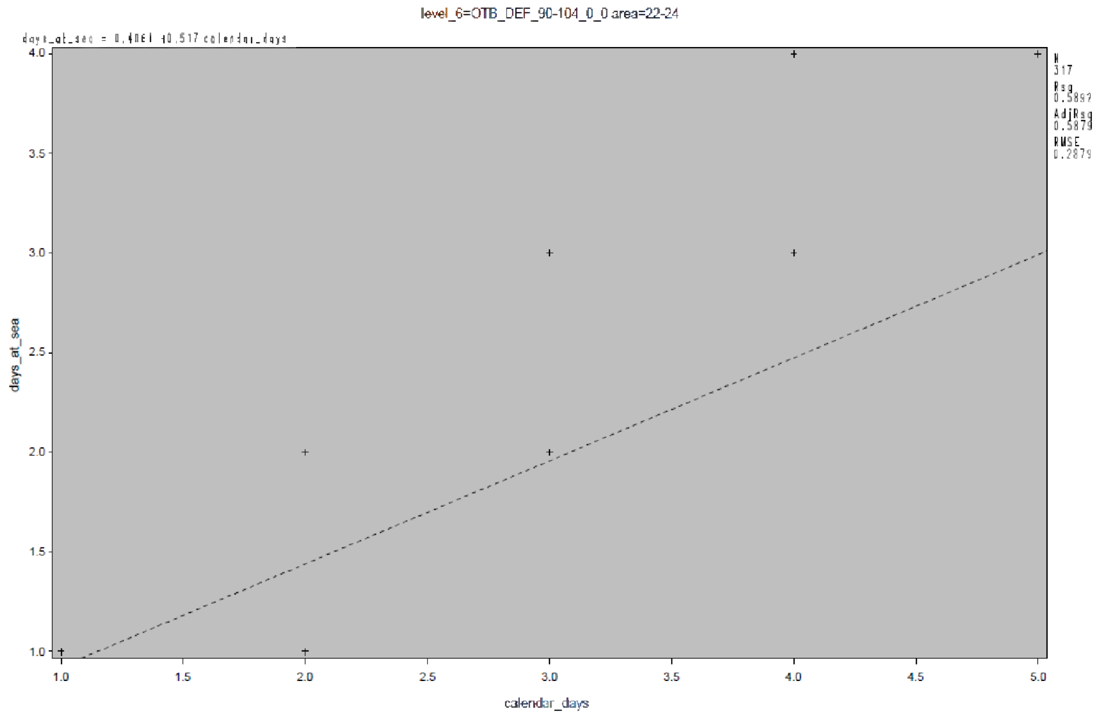


Figure 11.5 Correlation between effort in days-at-sea versus calendar days for selected main Danish Baltic cod fisheries by area in 2010. Demersal trawl metier Western Baltic Sea.

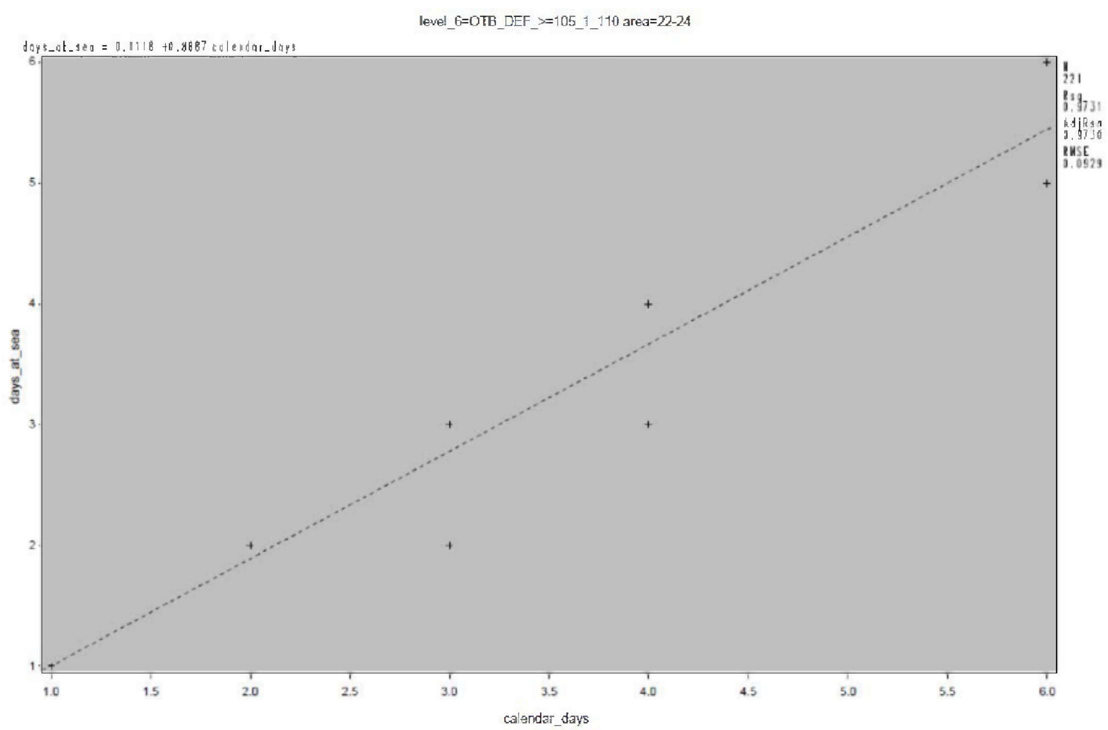


Figure 11.6 Correlation between effort in days-at-sea versus calendar days for selected main Danish Baltic cod fisheries by area in 2010. Demersal trawl metier Western Baltic Sea.

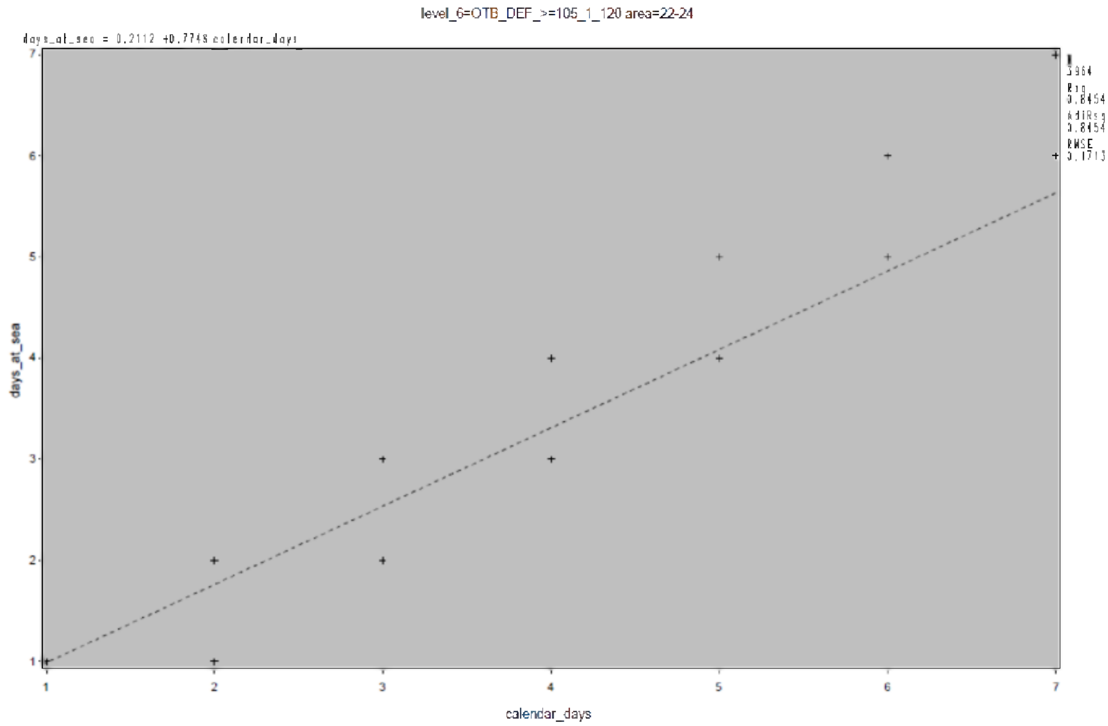


Figure 11.7 Correlation between effort in days-at-sea versus calendar days for selected main Danish Baltic cod fisheries by area in 2010. Danish seine metier Western Baltic Sea.

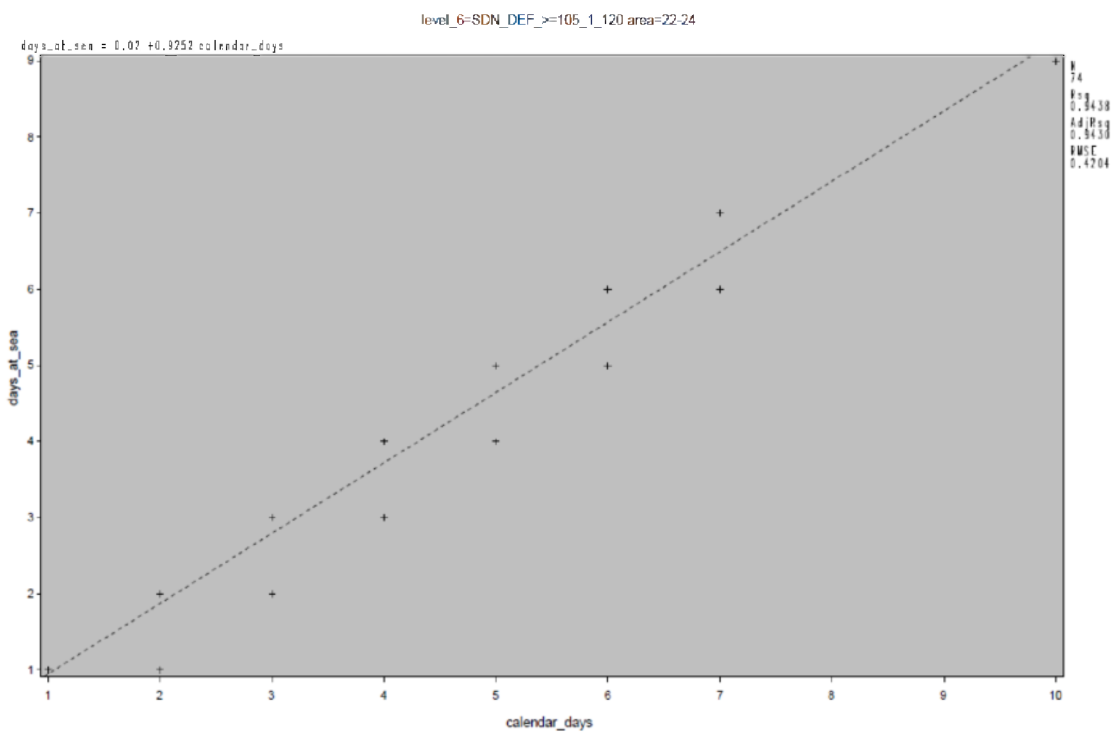


Figure 11.8 Correlation between effort in days-at-sea versus calendar days for selected main Danish Baltic cod fisheries by area in 2010. Demersal trawl metier Eastern Baltic Sea.

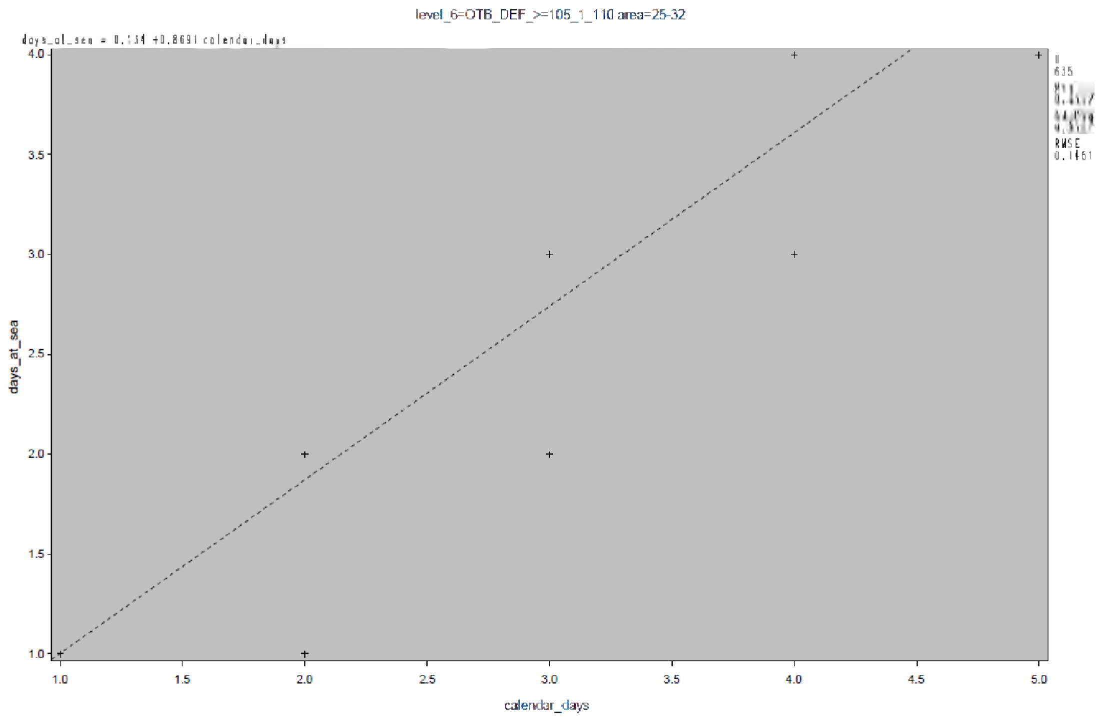


Figure 11.9 Correlation between effort in days-at-sea versus calendar days for selected main Danish Baltic cod fisheries by area in 2010. Demersal trawl metier Eastern Baltic Sea.

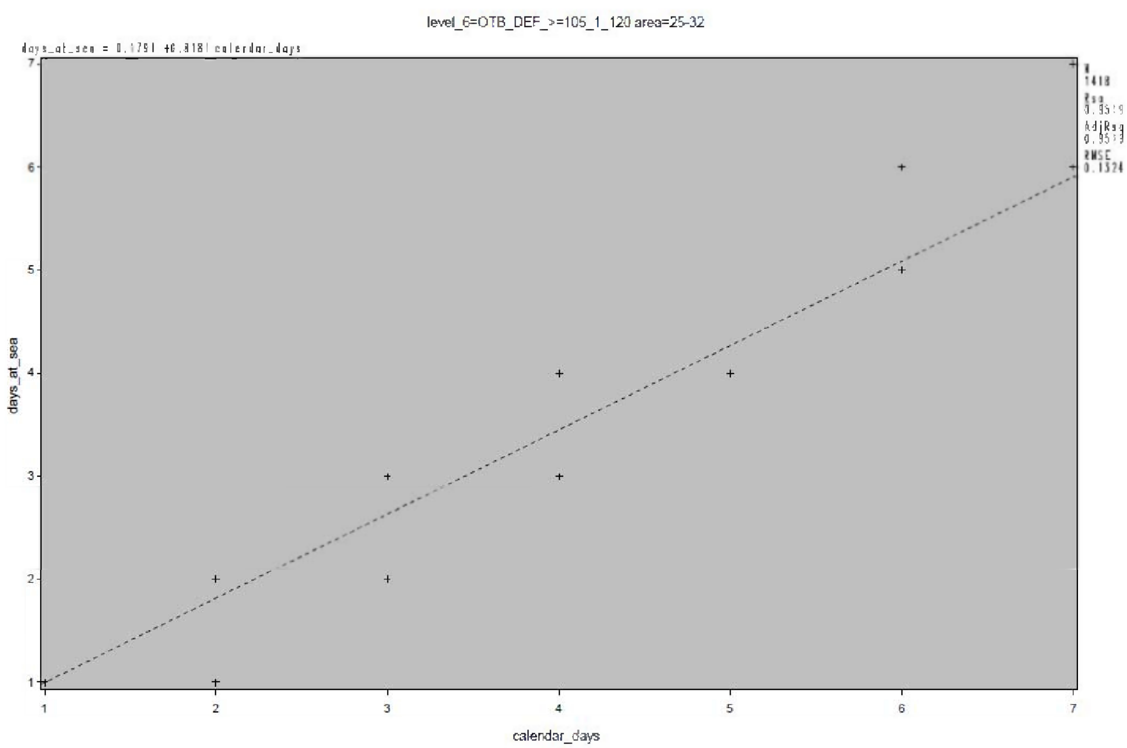


Figure 11.10 Correlation between effort in days-at-sea versus kWdays for selected main Danish Baltic cod fisheries by area in 2010. Gillnet metier Western Baltic Sea.

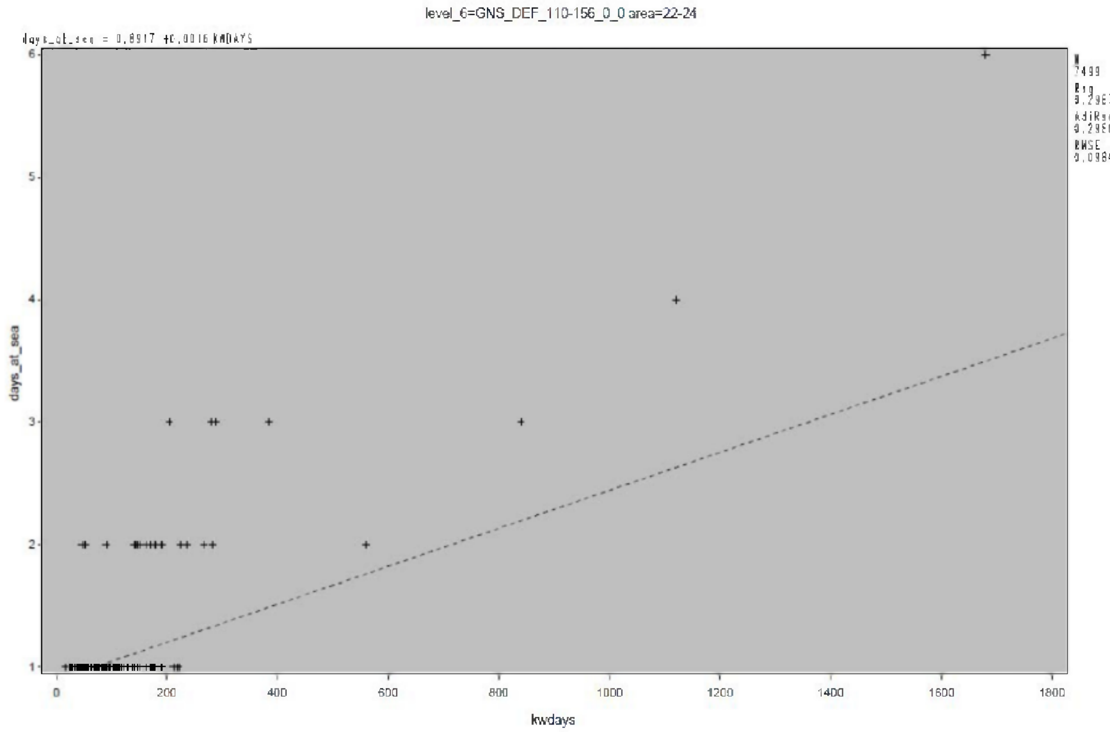


Figure 11.11 Correlation between effort in days-at-sea versus kWdays for selected main Danish Baltic cod fisheries by area in 2010. Gillnet metier Western Baltic Sea.

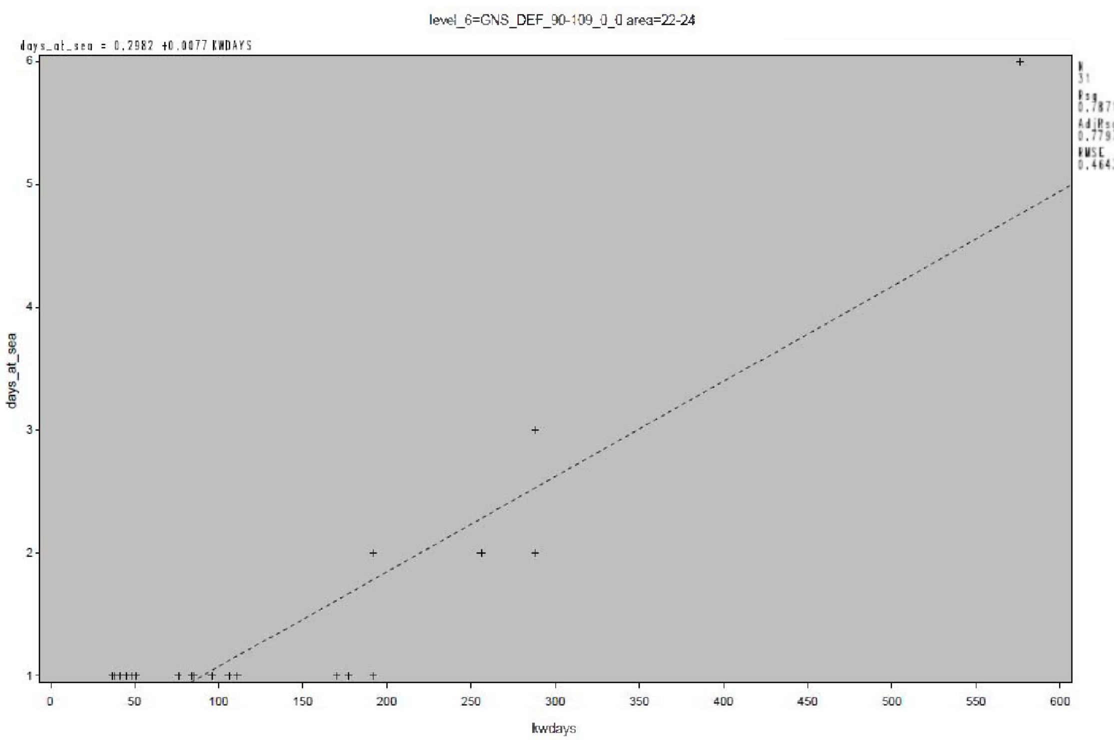


Figure 11.12 Correlation between effort in days-at-sea versus kWdays for selected main Danish Baltic cod fisheries by area in 2010. Gillnet metier Western Baltic Sea.

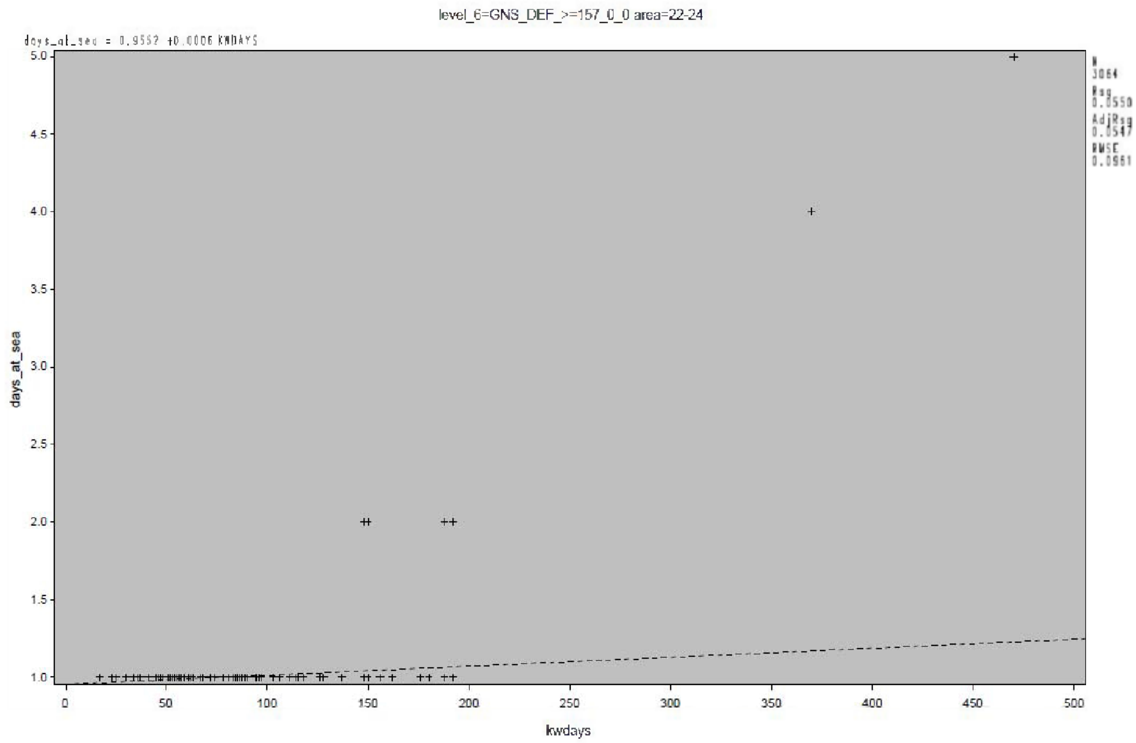


Figure 11.13 Correlation between effort in days-at-sea versus kWdays for selected main Danish Baltic cod fisheries by area in 2010. Demersal trawl metier Western Baltic Sea.

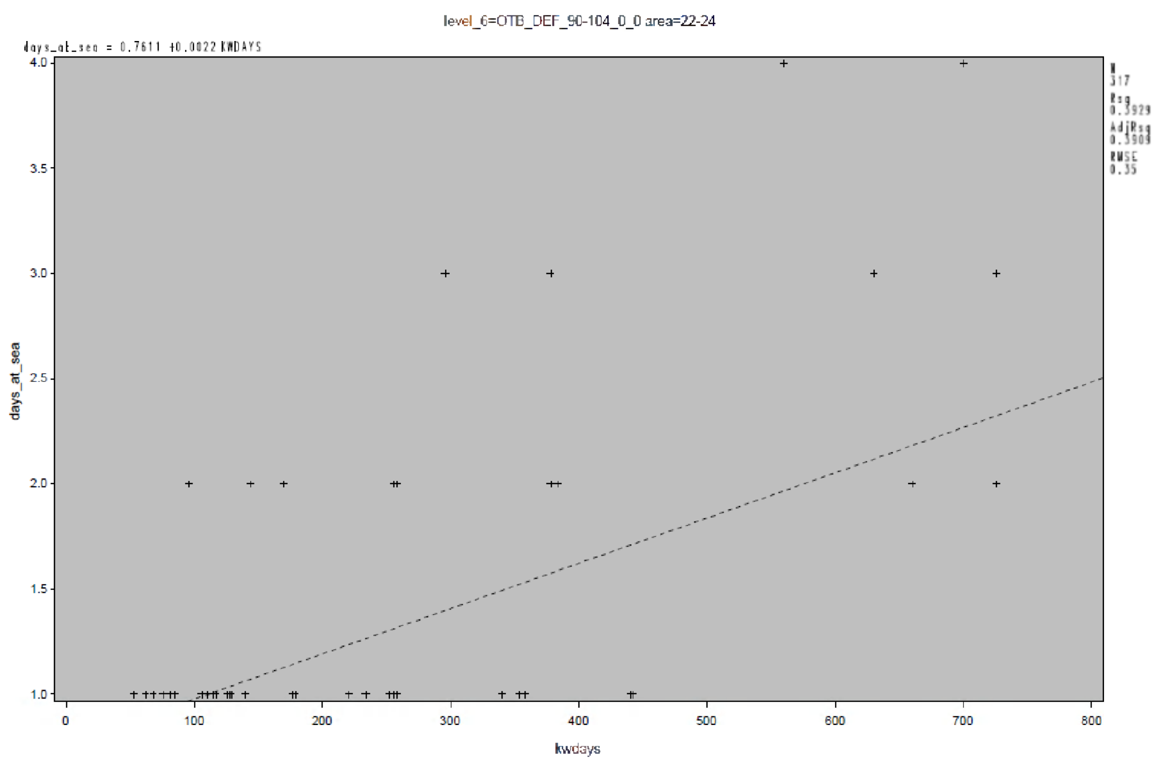


Figure 11.14 Correlation between effort in days-at-sea versus kWdays for selected main Danish Baltic cod fisheries by area in 2010. Demersal trawl metier Western Baltic Sea.

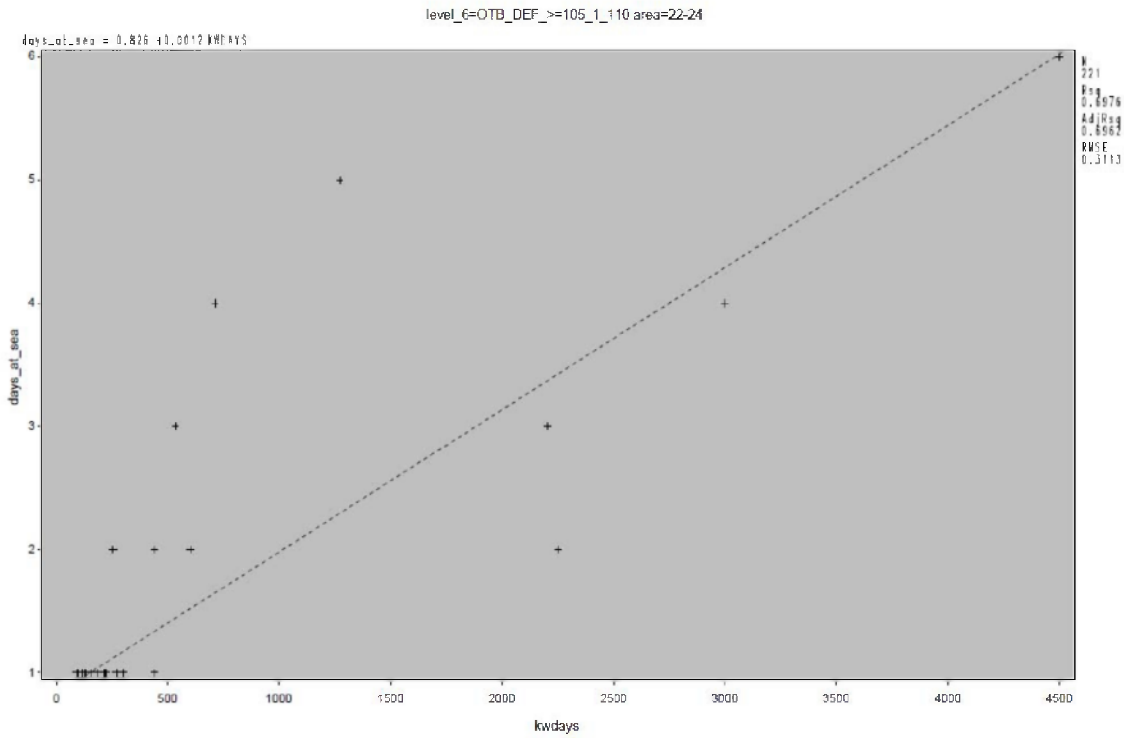


Figure 11.15 Correlation between effort in days-at-sea versus kWdays for selected main Danish Baltic cod fisheries by area in 2010. Demersal trawl metier Western Baltic Sea.

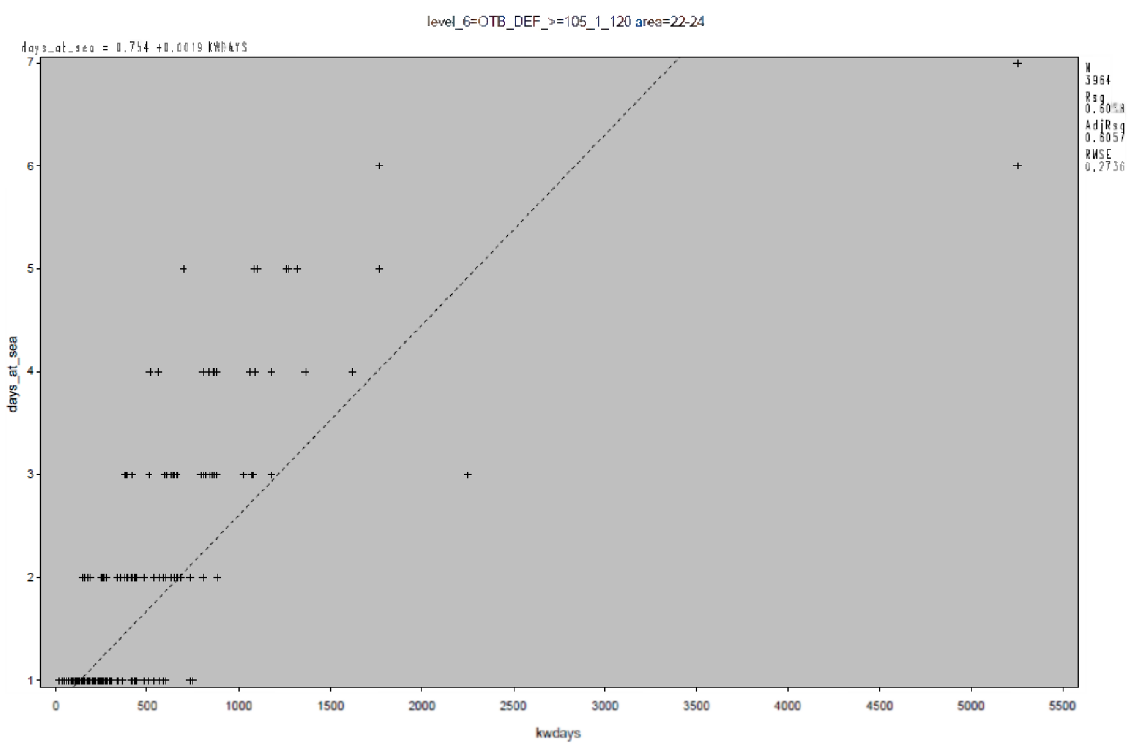


Figure 11.16 Correlation between effort in days-at-sea versus kWdays for selected main Danish Baltic cod fisheries by area in 2010. Demersal trawl metier Western Baltic Sea.

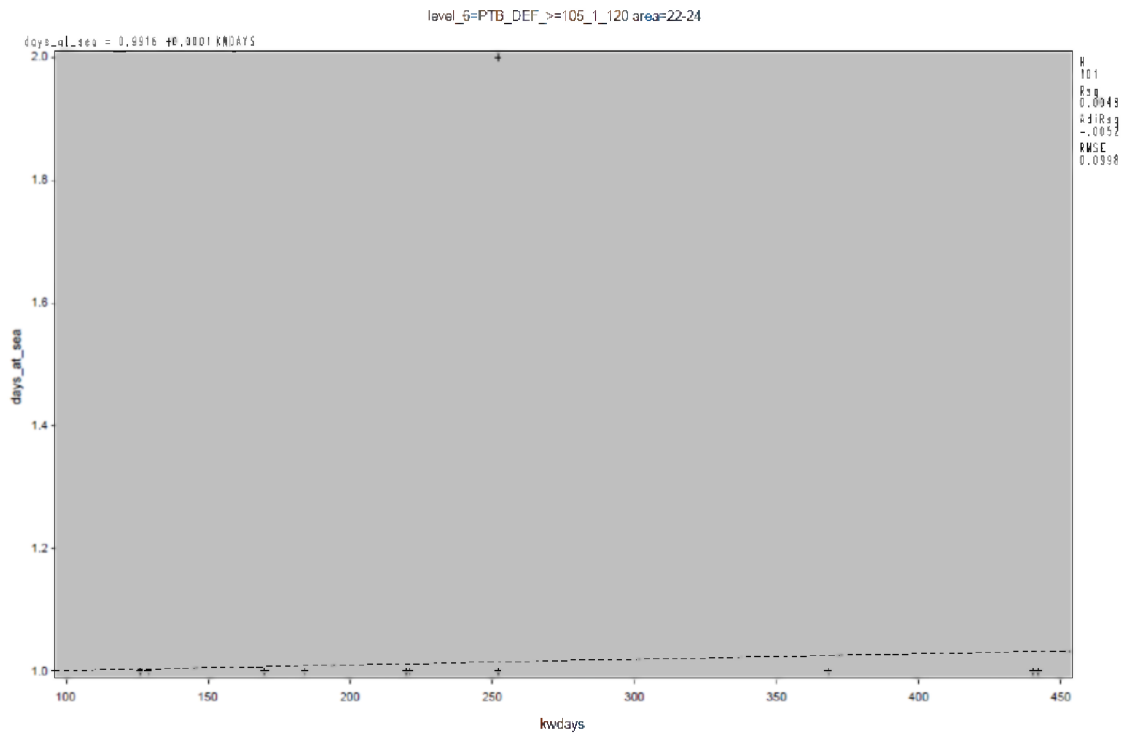


Figure 11.17 Correlation between effort in days-at-sea versus kWdays for selected main Danish Baltic cod fisheries by area in 2010. Danish seine metier Western Baltic Sea.

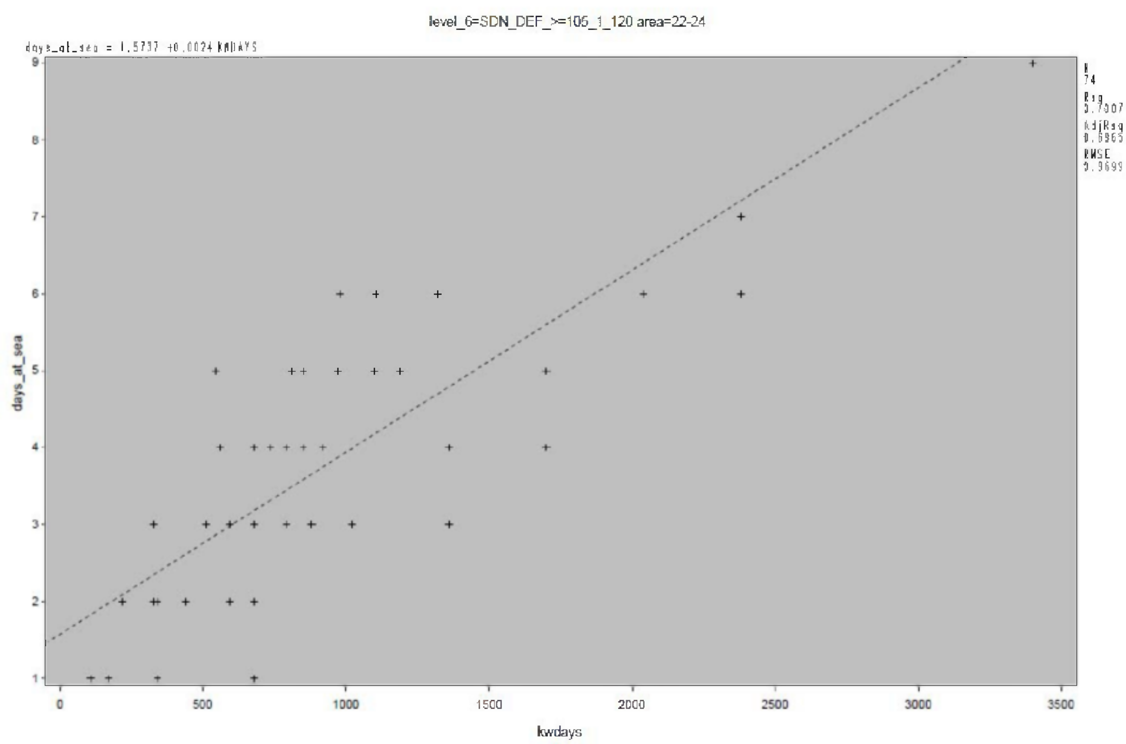


Figure 11.18 Correlation between effort in days-at-sea versus kWdays for selected main Danish Baltic cod fisheries by area in 2010. Demersal trawl metier Eastern Baltic Sea.

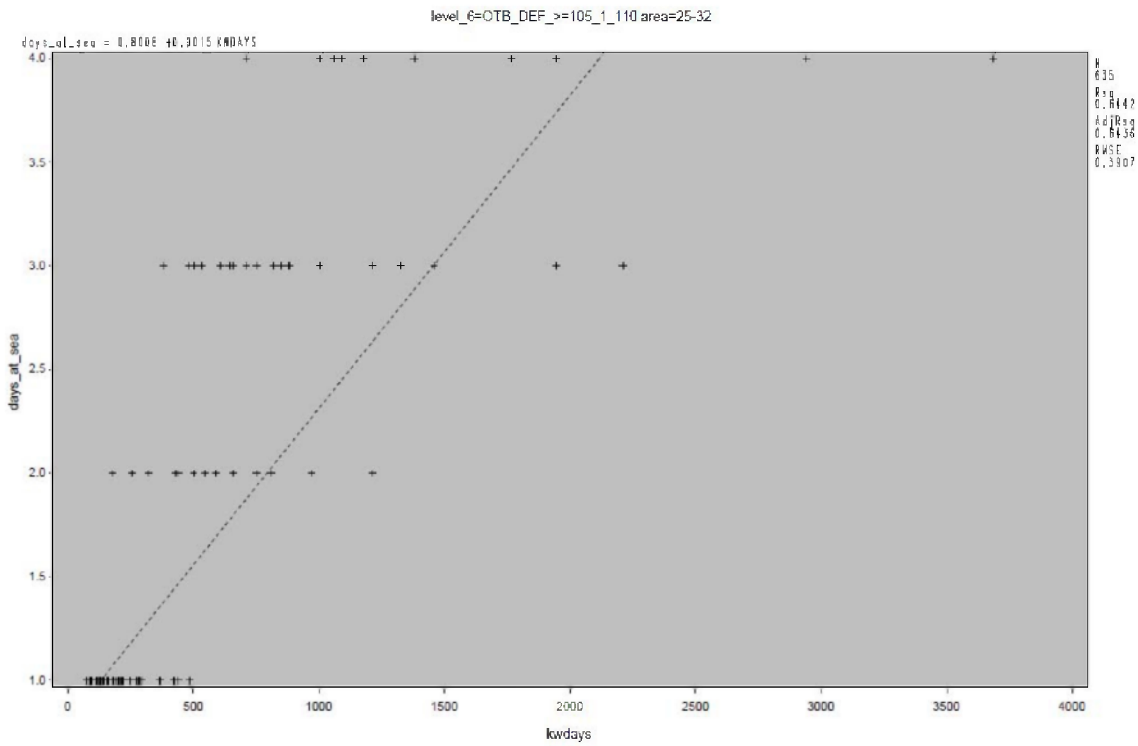


Figure 11.19 Correlation between effort in days-at-sea versus kWdays for selected main Danish Baltic cod fisheries by area in 2010. Demersal trawl metier Eastern Baltic Sea.

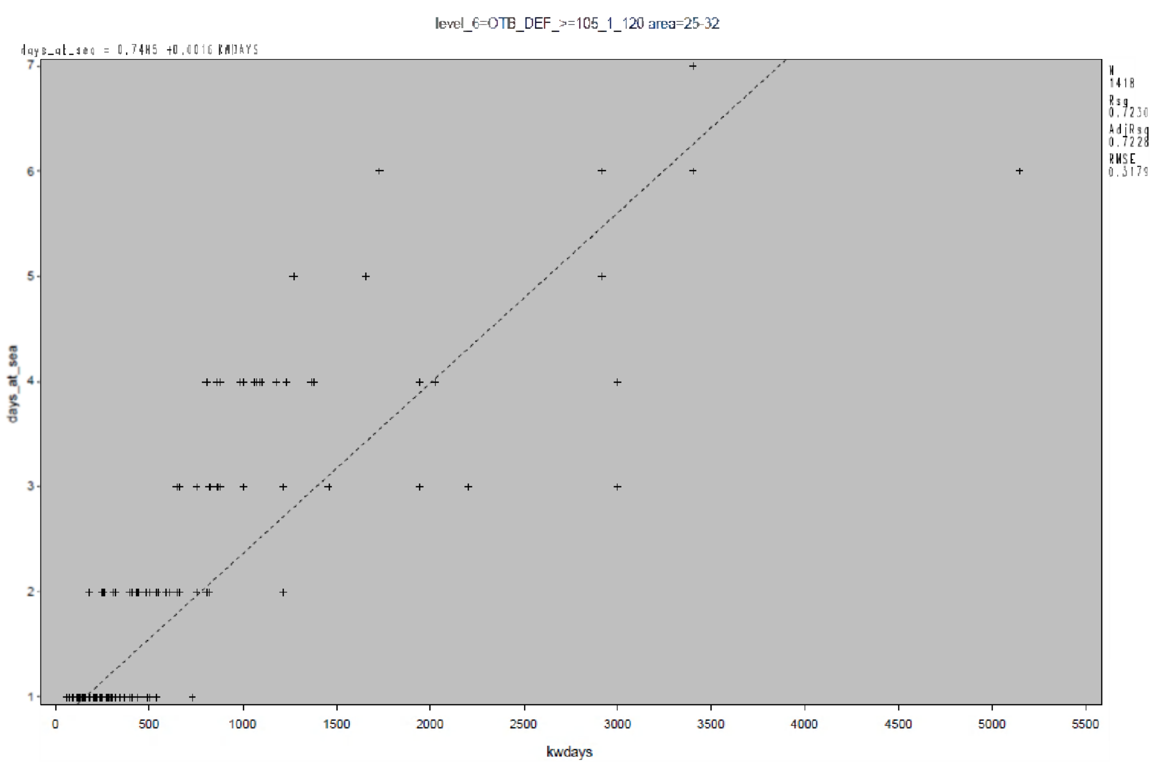


Figure 11.20 Correlation between effort in days-at-sea versus kWdays on an aggregated basis by year and fleet/fishery for Danish fisheries in the Western Baltic Sea for the period 2005-2010 made available to the EU STECF EWG group from the EU STECF SGMOS-11-06.

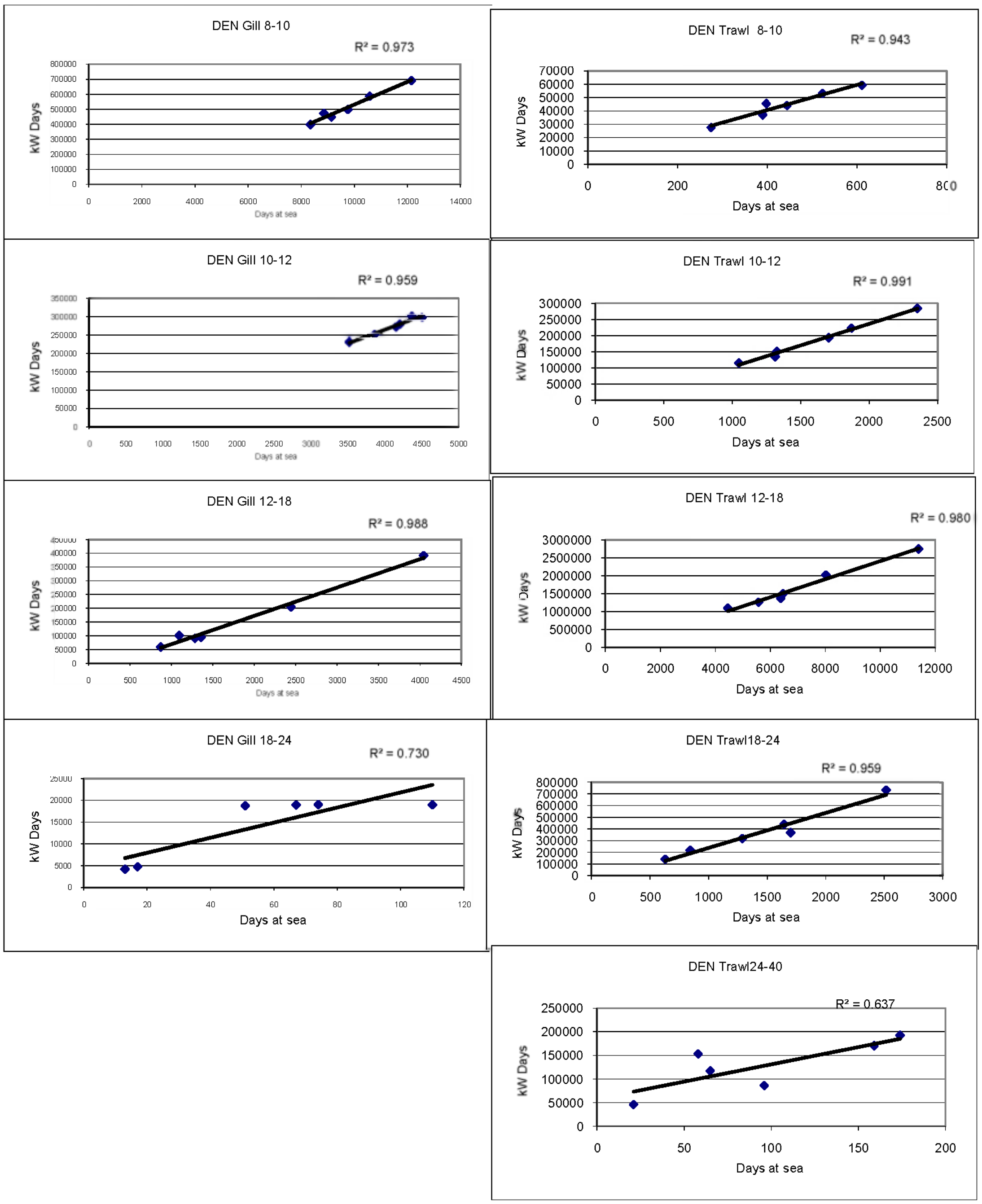


Figure 11.21 Correlation between effort in days-at-sea versus kWdays on an aggregated basis by year and fleet/fishery for German fisheries in the Western Baltic Sea for the period 2005-2010 made available to the EU STECF EWG group from the EU STECF SGMOS-11-06.

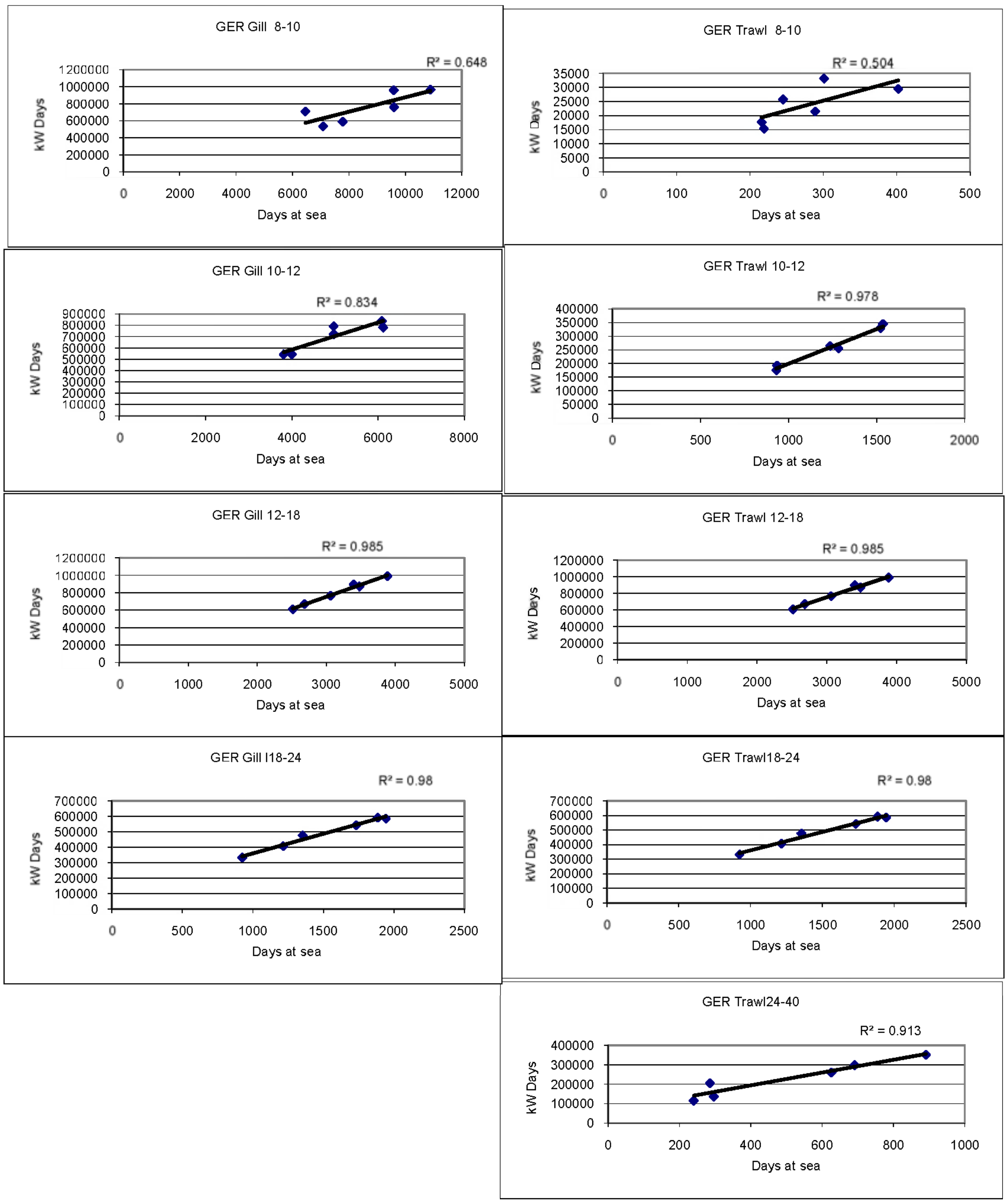
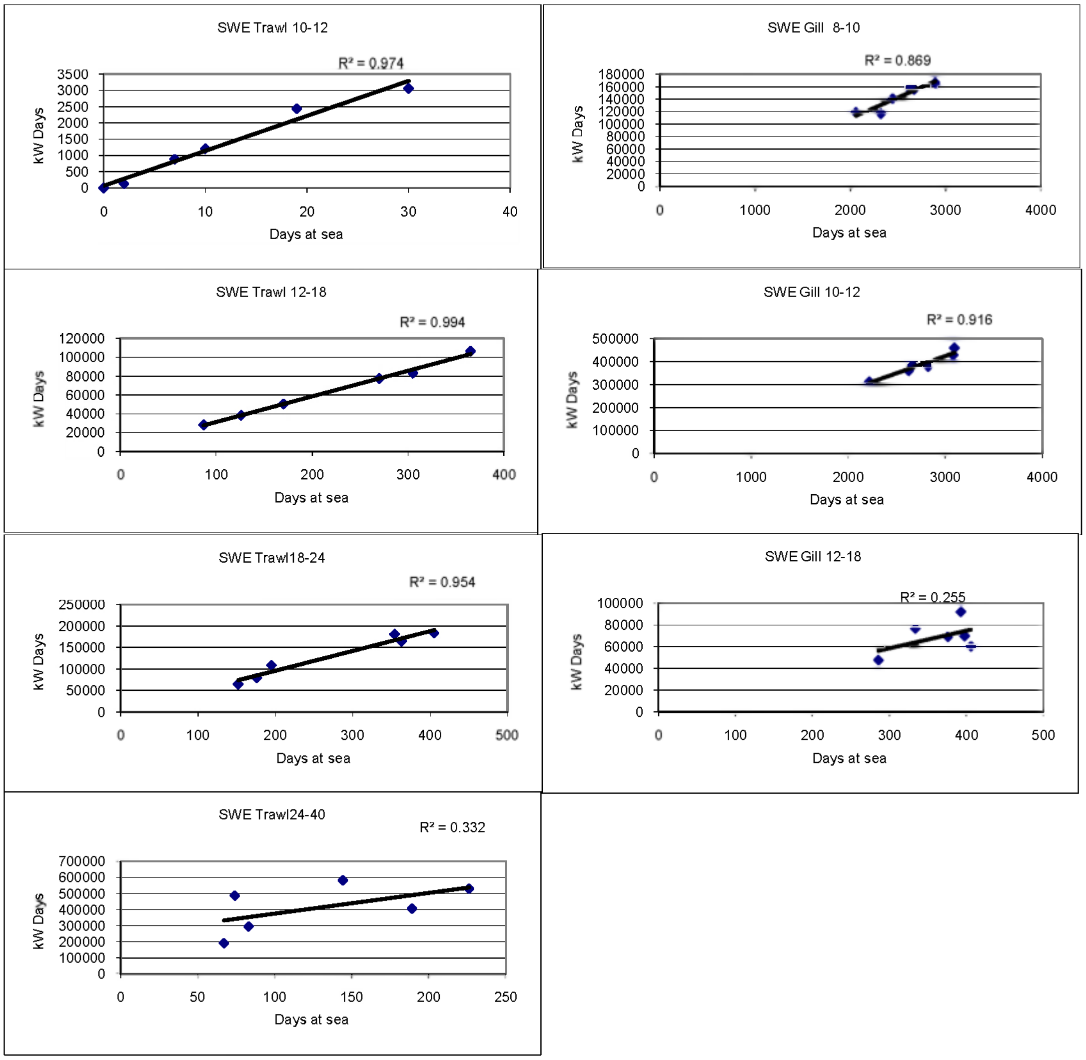


Figure 11.22 Correlation between effort in days-at-sea versus kWdays on an aggregated basis by year and fleet/fishery for Swedish fisheries in the Western Baltic Sea for the period 2005-2010 made available to the EU STECF EWG group from the EU STECF SGMOS-11-06.



11.3 Conclusions

The results of the initial analyses of correlation between different effort measures on trip basis for important métiers in the Baltic Sea by area in 2010 indicate that there is a relatively good correlation, but not full consistency, between the days-at-sea and calendar-days effort measures for all important (Danish) métiers in the two areas when evaluating dis-aggregated data on trip level, even though found variation between métiers.

The correlation between days-at-sea and kWdays are not equally high and is also more variable between métiers dependent on the spread in kW within the métier when evaluating Danish disaggregated data on trip level for 2010. The spread in the kWdays effort measure seems to be higher than for days-at-sea and the calendar-day effort measures because it is dependent on different spread in kW by vessel for the different métiers. Among other, there seems to be difference between métiers using active gears compared to passive gears in the correlation between effort measures.

The evaluation of consistency between days-at-sea and kWdays effort measures when using aggregated data from the SGMOS-11-06 by year and fleet/fishery for the period 2005-2010 for the Danish, German and Swedish fisheries in the Western Baltic Sea also indicate good correlation, but not full consistency.

Overall, these initial analyses indicate that there in general is a relatively good correlation, but not full consistency, between the different effort measures. Both the disaggregated and aggregated data analyses show that there is variability and inconsistency herein between métiers. Accordingly, the efficiency of effort measures according to registration and management will be variable dependent on which effort measure there is used. As such the results indicate that there will be different reductions in F according to the management plan between métiers dependent on which effort measure there is used. Also the reduction in F according to reduction in E will be dependent on the relative distribution between – as well as the level of consistency herein between years - of the absolute and relative activity of the different métiers with different fishing power, including possible transfer of effort between segments (see also section 12.3). The kWdays measure will only to a higher degree take into account development in fishing power to the extent fishing power depends mainly on the engine capacity which probably to a higher degree is the case for fisheries using active gears (e.g. trawl, seines) compared to fisheries using passive gears (e.g. gillnet, longlines).

The found differences indicate that the methods used to initially allocate effort to the vessels and the method for actually account effort to vessel according to the effort quota given in the LTMP have a high correlation, but in some cases will result in inconsistency between and within métiers and as such should be used with caution. To avoid such potential inconsistency problems it probably will be better to use the same effort measure in these processes.

See also section 12.3 for overall conclusions and considerations.

12.0 Correlation between Fishing Effort and Fishing Mortality

12.1 Introduction, purpose, materials and methods

In relation to values of baseline effort and utilized effort, the purpose of this section is to evaluate the relationship between fishing mortality, F, and overall effort, E, by management area and cod stock – and possibly by segment in relation to potential fishing power differences.

Concerning the used effort measures and baseline effort settings the aim is to evaluate the relationship between F and E and possible temporal development herein in order to evaluate fishing power differences over time and/or between fleet segments. The results of the analyses will indicate whether it is possible to re-distribute effort within and between segments without increasing total effort (E) and fishing mortality (F) and still reach the management targets. As such it will consider the flexibility with uni-directional or bi-directional effort transfer among segments and within segments.

This analysis is among other relevant in relation to evaluation of whether the management plan has been efficient in relation to the intentions, e.g. is there efficient F reduction when F is translated into E reduction when a Baltic stock is above F-targets?

The EU STECF SGMOS 09-05, EU STECF SGMOS-10-05 and EU STECF SGMOS-11-06 have produced correlation plots of fishing mortality F versus fishing effort E for all international Baltic cod fisheries combined by main gear (active and passive gears) and main area (Eastern Baltic Sea) for the most recent 5-year period.

Developments over time within and differences between Danish Baltic cod fishing fleets have previously been analysed in Nielsen (2000) and Marchal et al. (2001).

In relation to the FLR management plan evaluations and simulations produced to EU STECF EWG-11-07 there has been performed multi-variate GLM statistical analysis of fishing power differences between different international Baltic cod fisheries and métiers covering the period 2005-2009. This analysis has resulted in estimated average catcability by métier for this period as presented below.

Finally, there has in present context been made correlation plots of F vs E on a more disaggregated basis for individual international fisheries and métiers for the period 2005-2009 where both effort and landing data have been available on métier and area disaggregated basis to perform such analyses. The results of this preliminary analysis are also presented below.

12.2 Results

Nielsen (2000) and Marchal *et al.* (2001) found fishing power differences between different fleet segments and vessel size classes in the Danish Baltic cod fisheries as well as an increase in fishing power over time within the fleets and fisheries among other according to vessel size. Both analyses using two different methods to estimate fishing power by segment found a continuous small, but significant increase for nearly all segments over time during the investigated 10 year period in the 1990'ies.

Below is given the results of the more aggregated correlation analyses between fishing mortality and effort in the international Baltic cod fishery by main gear for the Eastern Baltic Sea (SD 25-32) and the Western Baltic Sea (SD 22-24) as estimated by EU STECF SGMOS-11-06.

Figure 12.1 From EU STECF SGMOS-11-06: Results of F (vertical axis) versus fishing effort (kW*days at sea) aggregated for all international Baltic cod fisheries divided by main gear. (Note that not only effort reductions are possibly responsible for the drop in F during the last years. An improved productivity of the stock and the TAC constraint of +/- 15% in the cod management plan could also have contributed. The results should be interpreted with caution.

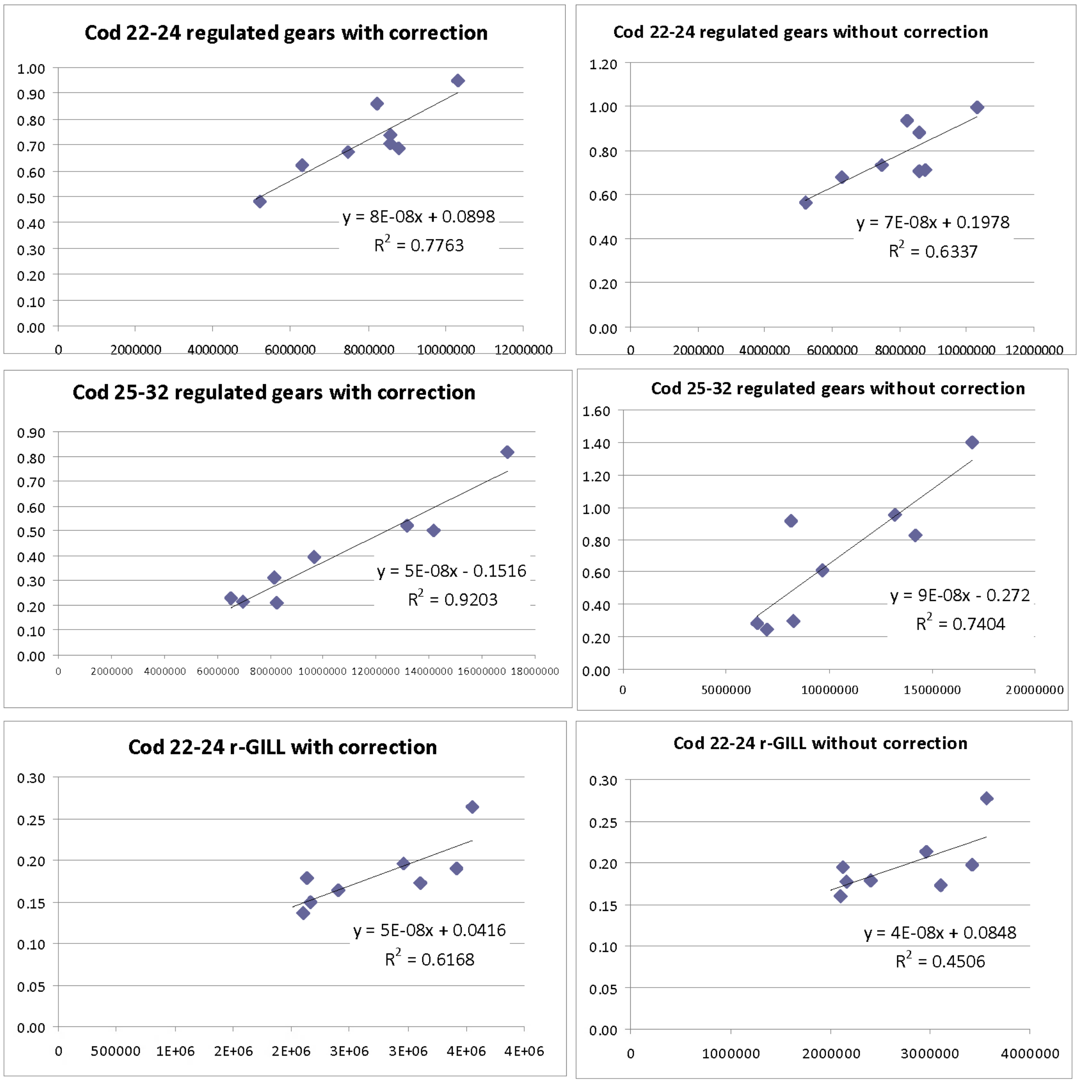
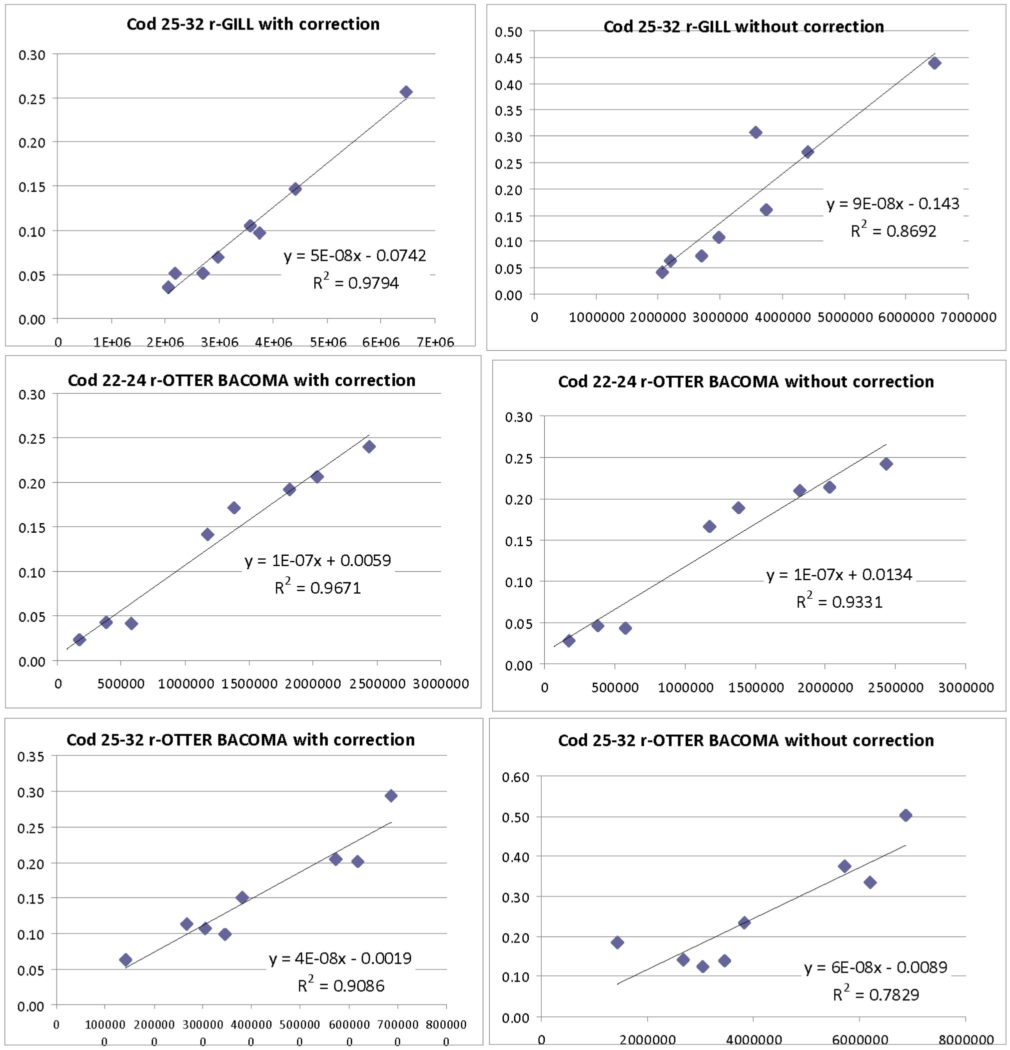


Figure 12.1 (Continued)



On basis of this more aggregated plots of F versus E for recent Baltic cod fishery by area in the period of 2005-2010 then it is in STECF SGMOS-11-06 report concluded that the relationships between fishing mortality and effort deployed (for all regulated gears combined) are on an aggregated basis strong for the Western and Eastern Baltic cod fisheries. According to STECF SGMOS-10-05 and SGMOS-11-06, the results change to some extent depending on whether the analysis is based on F from ICES assessments or an STECF estimated partial F assuming that effort data show the same bias as STECF catch estimates (i.e. without unallocated removals) compared to ICES catch estimates (i.e. with unallocated removals). The general conclusions, however, hold true for both types of analyses. It is furthermore in SGMOS-10-05 concluded that the intersection of the regression line with the x-axis (see Figure 12.1 above) would imply a zero catch of eastern Baltic cod already at around 5 million kW*days. This is a hint that the relationship is to some extent spurious and other factors besides effort reductions are responsible for the drop in F during the last years. For example, improved productivity of the stock and the TAC constraint of +/- 15% in the cod management plan contributed to this. Therefore interpretation of these results should be carried out cautiously.

In relation to the FLR simulations performed for EU STECF EWG-11-07 there has been performed a statistical multivariate GLM analysis of fishing power by segment (métier) for the western Baltic cod fishery during the period 2005-2009 in order to scale the fishing power between segments. This was performed as an GLM analysis of CPUE by fishery (segment) where the spatial (geographical) and periodical effects were taken into account in order to calculate an average fishing power (catchability, fishing efficiency) difference between segments as averages for the period 2005-2009 in the Western Baltic Sea. The results of this analysis are shown in Table 12.1 below.

The results from this preliminary analysis are consistent with similar results of analyzing fishing power in Danish Baltic cod fisheries presented in Nielsen (1999) and in Marchal *et al.* (2001) where there are documented significant differences in catchability and fishing power between different segments according to fishery (gear type, vessel size, etc).

Table 12.1 Catchability or fishing power differences between segments (métiers) in the international Western Baltic cod fishery during the period 2005-2009 as estimated from GLM analysis using to inform the FLR modeling for the EU STECF EWG-11-07.

metierothfleet_TR1	6.023836
metierGER_24-40_Otter_TR1	4.607987
metierSWE_u24_Otter_TR1	3.415169
metierDEN_24-40_Otter_TR1	2.19964
metierGER_24-40_Pelagic_OTH2	1.142151
metierDEN_u24_Dseine_TR1	1.0162
metierothfleet_nomesh	1.009615
metierDEN_u24_Otter_TR1	1
metierGER_24-40_othmet_nomesh	0.847841
metierDEN_u24_Static_nomesh	0.574111
metierGER_u24_Otter_TR1	0.52387
metierDEN_u24_othgr_nomesh	0.519104
metierDEN_u24_Otter_TR2	0.454818
metierDEN_u24_othmet_nomesh	0.361903
metierSWE_u24_Static_nomesh	0.332824
metierSWE_u24_othgr_nomesh	0.243899
metierGER_u24_Pelagic_OTH2	0.223567
metierDEN_24-40_othmet_nomesh	0.162919
metierDEN_u24_Pelagic_OTH1	0.158607
metierSWE_24-40_Pelagic_OTH2	0.148297
metierGER_u24_Static_nomesh	0.131044
metierGER_u24_othmet_nomesh	0.125334
metierGER_u24_Otter_TR3-2	0.112942
metierGER_u24_othgr_nomesh	0.089394

Correlation plots of F vs E on a more disaggregated basis for individual international Baltic cod fisheries and métiers by area for the period 2004-2009 where both effort and landing data are available on métier and area disaggregated basis to perform such analyses are presented below in Figures 12.2 to 12.5.

The results of this preliminary correlation analysis with use of effort in fishing days (shown in Figs. 12.2-12.3) and in kWdays (shown Figs. 12.4-12.5), respectively, indicate that the correlation between effort and fishing mortality on a more disaggregated level on international métier and area basis varies considerably between different fisheries and metiers by area in the international Baltic cod fisheries. For some métiers there is a high correlation while the dependency is indicated to be low for other fisheries in both areas, and the slopes of the correlations also varies considerably indicating fishing power differences.

Figure 12.2 Correlation between effort in fishing days and F for on disaggregated level for individual international fisheries and métiers in the Western Baltic Sea for 2004-2009 where both effort and landing data are available on métier and area disaggregated basis.

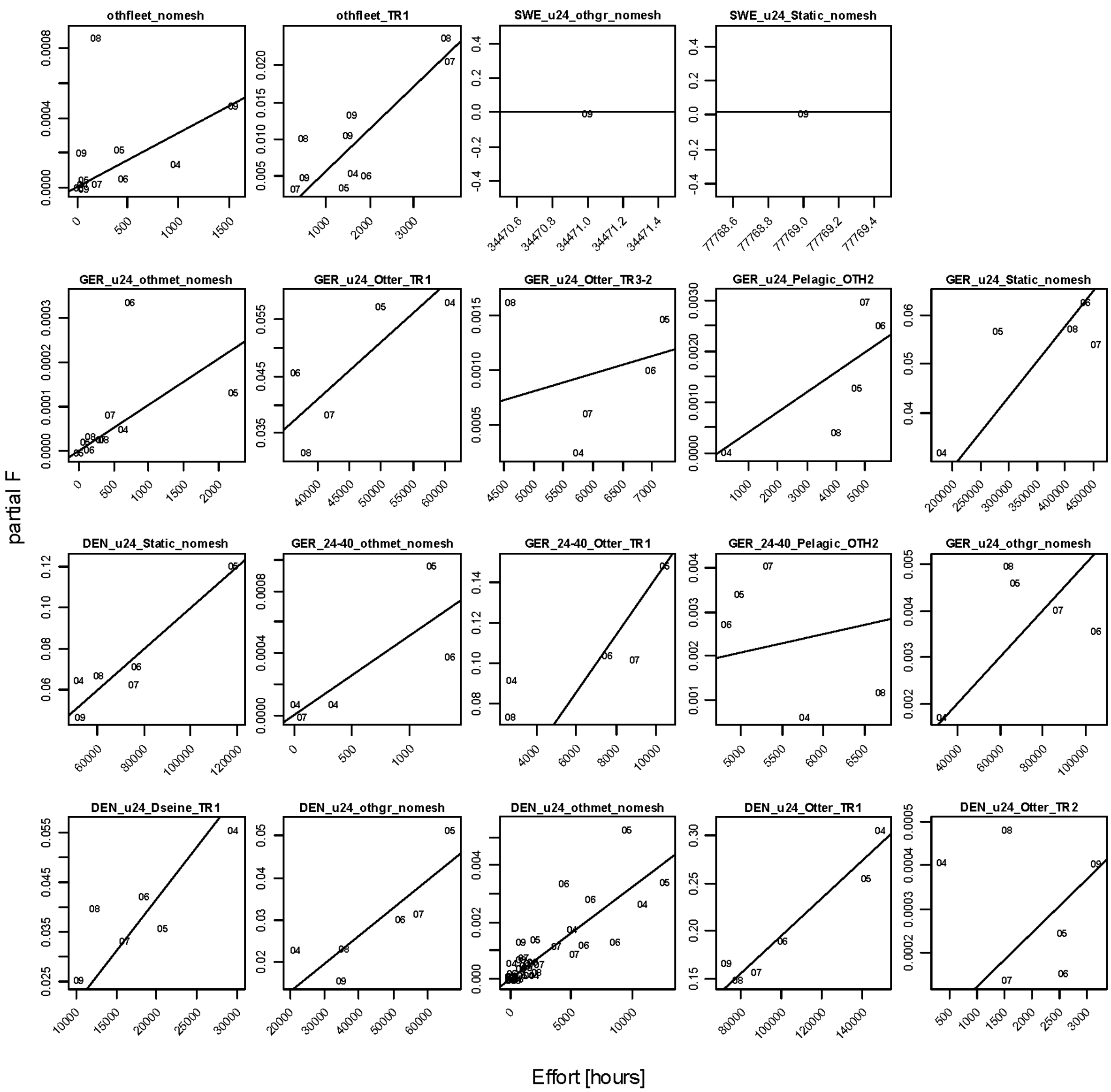
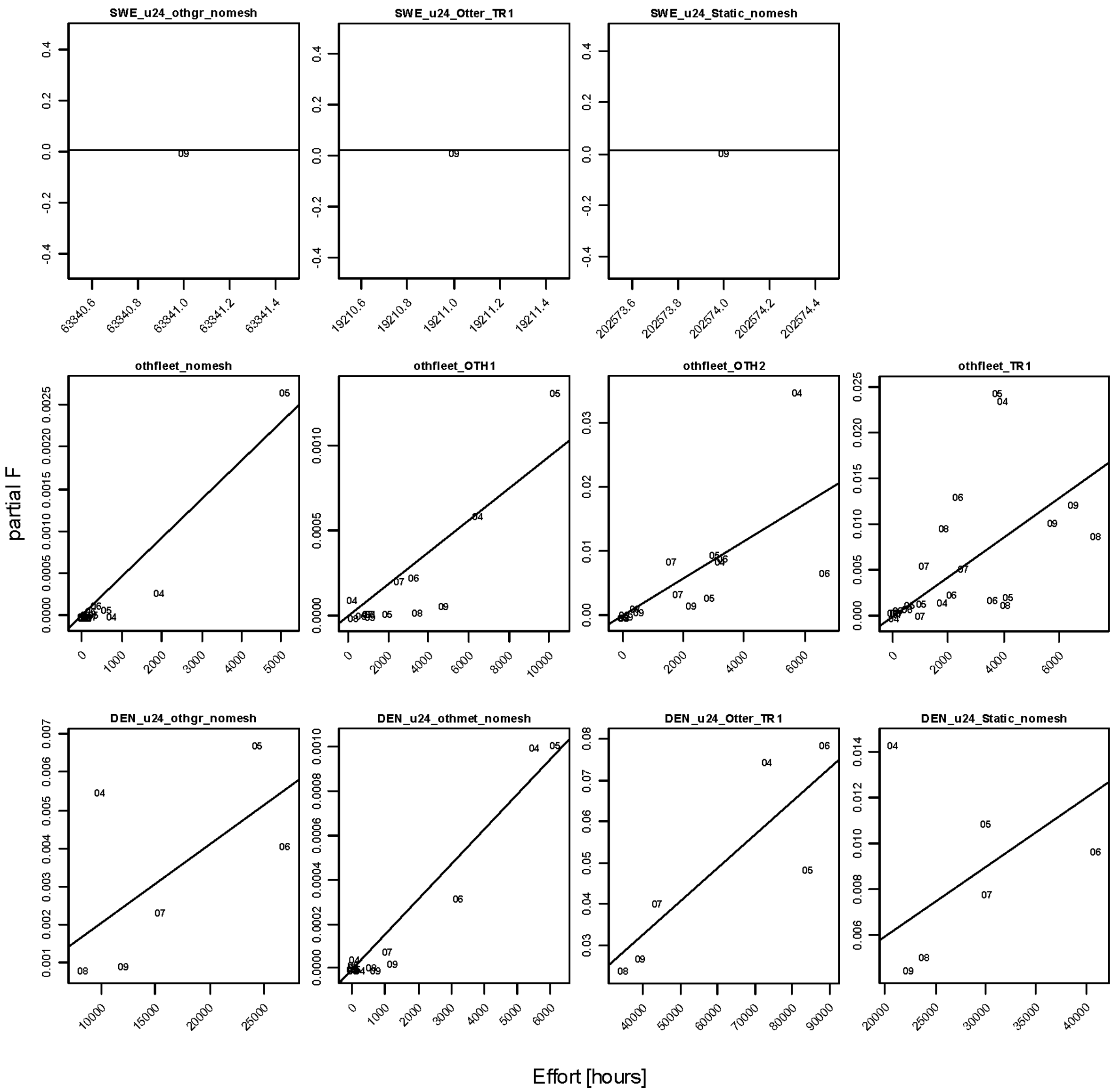


Figure 12.3 Correlation between effort in fishing days and F for on disaggregated level for individual international fisheries and métiers in the Eastern Baltic Sea for 2004-2009 where both effort and landing data are available on métier and area disaggregated basis.



Similar plots of F versus E for the Danish métiers with use of effort in kWdays shown in Figures 12.4 and 12.5 indicate that by use of the effort measure in kWdays do not improve the correlations and the variability in the correlation according to métier and area.

It should be noted that the correlations are affected by the fact that it is not only cod targeting effort (here in kWdays) which is included in the plots. The data are obtained by merging total effort by ICES statistical rectangle per quarter for each fleet with cod landing per rectangle per quarter per fleet. An alternative would have been to merge on trip-based data assigning e.g. a cod métier from the analysis of the landing composition and accordingly account the associated effort for this only, and accordingly only use the cod targeting trips and fishery. However, as the purpose is to qualify the DCF categories then it would not be correct to focus only on defined cod trips. Accordingly, the presented plots are most meaningful in present context.

Figure 12.4 Correlation between effort in kWdays and F for on disaggregated level for individual international fisheries and métiers in the Western Baltic Sea for 2004-2009 where both effort and landing data are available on métier and area disaggregated basis.

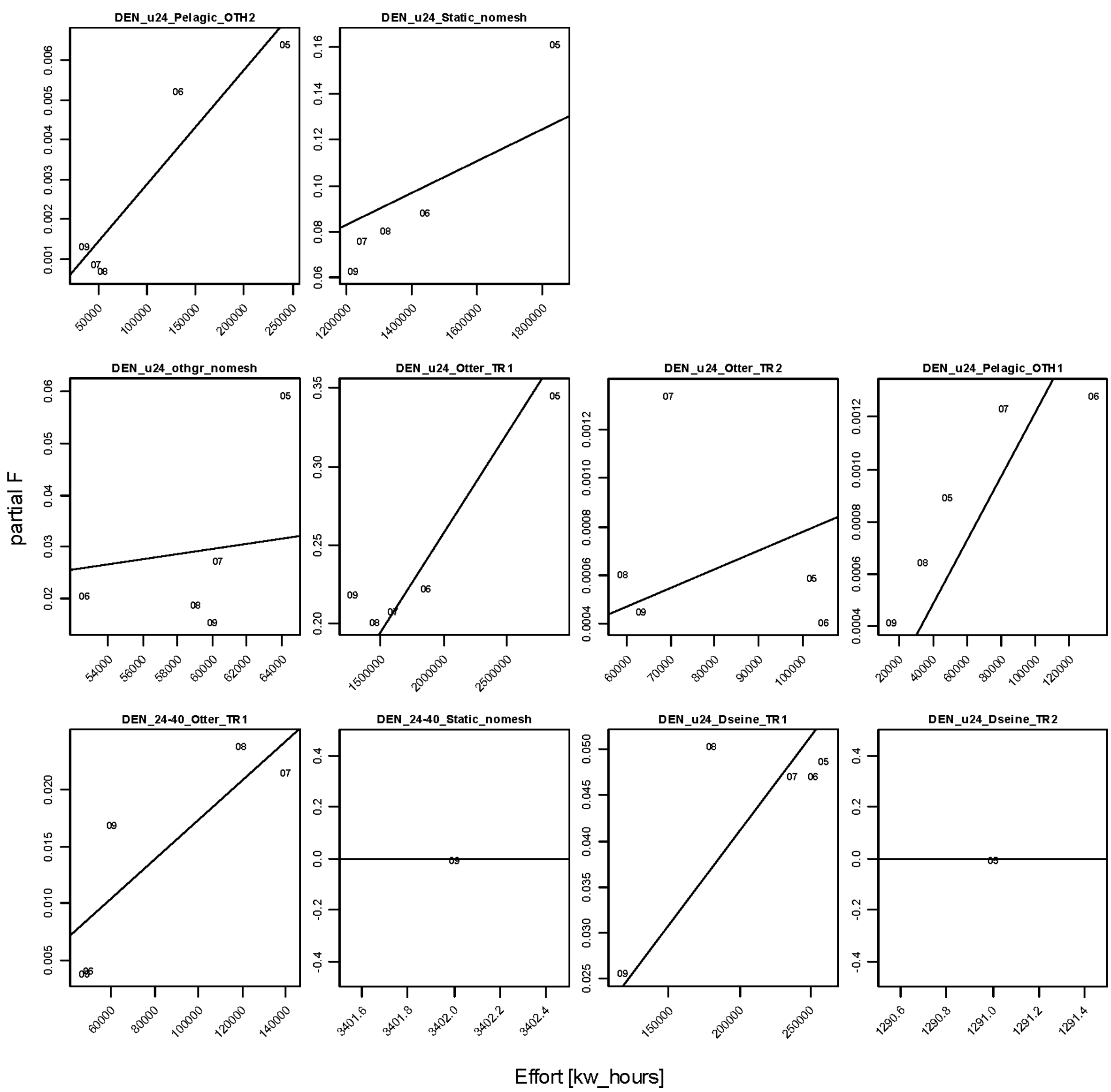
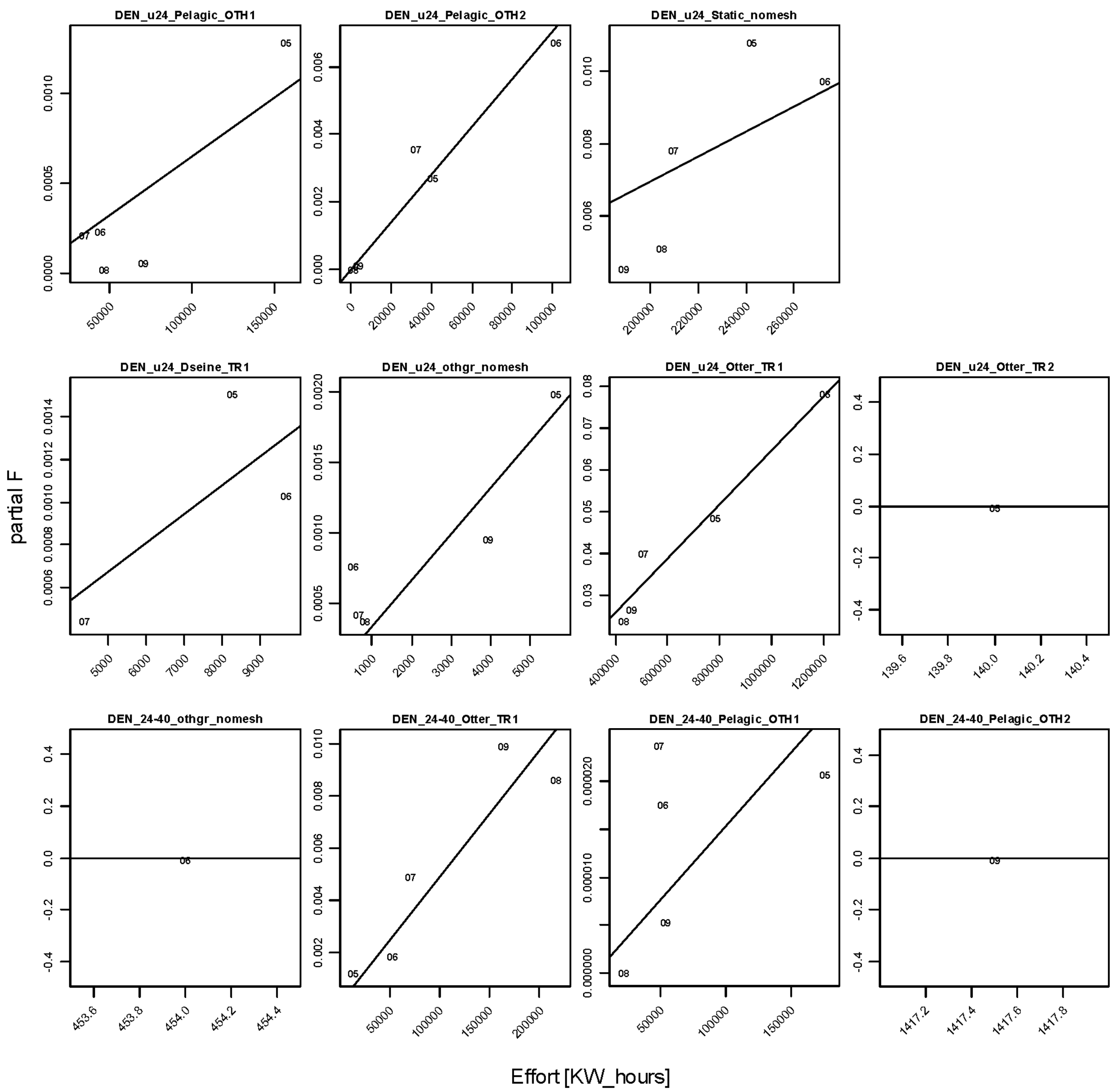


Figure 12.5 Correlation between effort in kWdays and F for on disaggregated level for individual international fisheries and métiers in the Eastern Baltic Sea for 2004-2009 where both effort and landing data are available on métier and area disaggregated basis.



12.3 Conclusions

In conclusion, possible transfer of effort between segments and countries should take the found difference in fishing power into account in order not to inflict the purpose and effect of the LTMP by potential increase of F by transfer of effort between segments without correcting for fishing power differences. Even though EU STECF SGMOS-10-05 and EU STECF SGMOS-11-06 results indicate a good overall correlation between E and F for Eastern and Western Baltic cod fisheries on an aggregated basis by main gear, then the correlation on a more disaggregated level by international métier and area indicate that the correlation varies considerably between different fisheries and metiers by area in the international Baltic cod fisheries. Overall, the results of the analyses indicate that it will not be possible to re-distribute effort within and between segments without increasing total effort (E) and fishing mortality (F), and the flexibility with uni-directional or bi-directional effort transfer among segments and within segments is limited unless the fishing power differences are taken into account and calculated in when transferring effort.

In relation to the overall conclusions reached from the preliminary analyses and results in sections 11 and 12, a row of considerations can be summarized in relation to this:

1) The current effort ceilings have been restrictive for only a smaller proportion of vessels (less than 10%, and in given case mainly for gillnetters)

2) Up to now effort control has probably not provided significant restraint in the fishery

3) The current effort restrictions are unlikely to prove a significant restraint in the next 1-2 years unless made more restrictive. However, it needs in this context to be noted that present fishing mortality for both the Eastern and Western Baltic cod stocks in 2011 is forecasted to be below F_{TARGET} resulting in either constant or an actual increase in the effort ceilings for 2012 for both stocks as well as for the Eastern Baltic cod for 2011.

4) As there is a considerable level of surplus unutilized effort and capacity available, introduction of effort trade under the present regime with or without fleet based exchange rates also taking into account differences in fishing power would prolong the period over which effort restraint is largely ineffective (acknowledging that trade in effort would have a cost so it is intrinsically a restraint)

5) If effort constraint for the fishery was considered to be important as a control measure a number of changes would need to be considered, among other:
    a. Effort allocations per vessel based on track record (similar to TAC allocations)
    b. Utilization trade in effort requiring fleet based exchange rates.

6) Transfer of effort between segments, as well as use of effort management to reduce F by enforcing reduction in E, need to take into account and compensate for variability between métiers in the correlation between effort and fishing mortality
    a. Which effort measure is used as the correlation between effort measures are not equal between different métiers
    b. Different fishing power according to cod between different métiers
    c. Likely temporal trends (technological creep) in the relationship between effort and fishing mortality in general

13.0 References

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Simmonds John, Nielsen J. Rasmus, Eero Margit, Zimmermann Christopher, Berkenhagen Jörg, and Motova Arina. 2010. Report of the Sub Group on Management Objectives and Strategies (SGMOS 10-06). Part e) Evaluation of multi-annual plan for Baltic cod; 18-22 October 2010, Vigo (ESP). **Luxembourg: Publications Office of the European Union, 2010.**

Annex 3 Stock-based and fleet-based evaluation of the multi-annual management plan for the cod stocks in the Baltic Sea

- with respect to cod stock mixing and TAC vs. effort regulation under different constraints and stock conditions -

EU STECF EWG-11-07 Working Document, June 2011

14.0 Introduction

In relation to the EU STECF EWG 11-01 and EWG 11-07 impact assessment on evaluation of the multi-annual management plan (LTMP) for the cod stocks in the Baltic Sea there has been performed a row of management scenario simulations covering evaluation of different cod stock biological conditions and parameters such as effects of different levels of stock mixing, migration and stock recruitment on the management plan as well as evaluation of effectiveness of different management instruments and harvest rules including TAC and effort regulation including different levels of constraints on TAC and effort. This work is following up on the management plan evaluations performed during the EU STECF SGMOS 10-06 meeting in Vigo, October 2010 using the same methodological approach.

The primary management measure for demersal stocks in the Baltic and Division III is annual TACs. These are accompanied by annually regulated number of fishing days. Additionally, an extensive array of technical measures, including seasonal closed areas, minimum landing sizes, and regulations concerning codend mesh configuration and selectivity devices are implemented. (ICES, 2011).

Due to different regulations implemented in fisheries such as limitation in effort in terms of kW days in Kattegat and fishing days in the Baltic Sea, it is difficult to judge whether the quotas are currently restrictive for the demersal fisheries in the area (see also Nielsen *et al.* (2011) in form of another Working Document to STECF EWG-11-07).

15.0 Materials and Methods

The simulations have been performed with age-structured multi-stock and multi-fleet bio-economic models which have already been published and applied for the Baltic cod stocks and fisheries (Bastardie *et al.* 2010a,b; Nielsen and Limborg, 2009).

General description of the FLR models developed

DTU Aqua has developed and applied bio-economic multi-stock-and-multi-fleet based management evaluation and simulation models which can evaluate impacts of different management options and scenarios on stock biomasses, fleet fishing mortality, landings and discards (catches), as well as on the fleets with respect to effort levels and effort allocation, partial fishing mortality, and catches and fleet economy (income, costs, profit) given different exit-entry rules (capacity levels) in the fishery. The multi-stock-multi-fleet version of the developed FLR model (Bastardie *et al.*, 2010b) has a high spatial and seasonal level of resolution and disaggregation, and is already applied for both Baltic cod stocks and all international Baltic cod fisheries (EU DCF métier). The FLR models are in general capable of evaluating bio-economic effects of different biological conditions such as different recruitment levels and growth and migration rates on stock level as well as fisheries consequences in relation to biological (F_{MSY}) and fleet economic (e.g. positive profit by fleet) sustainability criteria. As such the models can evaluate the impacts on stocks and fisheries of different management options (e.g. technical rules, fishing closures, etc.) and different management strategies and systems, taking into account different environmental and climate determined biological pre-conditions for the stocks as well as considering different technical interactions between fleets.

These FLR (Fisheries Library in R) fisheries bio-economic simulation models enables comparison of relative stock and bio-economic performances of different scenarios and options for fisheries management instruments, different management measures under different stock conditions and fisheries conditions framed in a yearly feedback loop between an operating model (OM) and a management procedure (MP) within the so-called management strategy evaluation (MSE) framework. This evaluation of management scenarios can be performed both after but also before implementation of management similar to the principle in a flight simulator with respect to effect evaluation and impact assessment both in the short term and the long term (multi-annual effects) of different management options before implementation. These tools parameterized in present context (see below), the whole concept of the development of the management evaluation tools, as well as further developments of these into individual based models are published in Nielsen and Limborg (2009) and in Bastardie *et al.* (2010a,b,c,d).

Actual application of the FLR Models in present context

In the simulations covering among other the stock mixing and multi-species considerations in relation to MSY F-targets (MSY management reference points) as well as different TAC and Effort management instruments and relative annual variability constraints herein under different recruitment scenarios there has been used a multi-stock and single fleet based model version (Bastardie *et al.* 2010a) covering both the Baltic cod stocks and all international Baltic cod fisheries combined into one fleet by management area (Eastern and Western Baltic Sea). Among other different management, stock biological consequences have been evaluated for different migration rates by age and area between stocks under different fishing pressures as well as under different recruitment scenarios, different initial stock population sizes, and different management systems and constraints. This modeling includes up-date information among other from ICES WGBFAS 2011 and up-date simulations from EU STECF SGMOS 10-06b with the methodological approach and simulation model used here. The simulations are stochastic projections (2011 to 2025, 100 iterations for each scenario, constant seed between scenarios) of the stock status (Recruits, N and F) and yield accounting for various uncertainties (process, observation and implementation errors) occurring at different steps of the MSE.

Also the simulations cover evaluation of different management instruments such as TAC regulation under different relative annual variability constraints either alone or together with effort regulation, as well as effort regulation alone (also under different constraints) and results based management including TAC regulation under a catch quota system. This type of simulations have been performed with a multi-fleet-single-stock version of the model including all international DCF métiers (fisheries) but only applied for the Western Baltic cod stock (one stock) and management area in present context. This modeling is performed on a highly disaggregated seasonal and spatial scale using the spatial and seasonal explicit application of the FLR model. Incorporating the spatial scale into the more elaborated stochastic fleet-based forecast model was planned to integrate potential effects of the population dynamics and the age-specific spatial distribution of the population together with the spatial and temporal allocation of fishing effort also including the heterogeneity of fishing practices. This model is published in Bastardie *et al.* (2010b) and has been up-dated with information from among other ICES WGBFAS 2011 (ICES 2011) as well as up-dated fisheries information from the EU STECF effort evaluation working group and also with information from EU STECF SGMOS 10-06 (Simmonds *et al.*, 2010).

The evaluations are performed and organized as follows:

Section 3: FLR Model Settings in relation to Baseline (no change)

Section 4: Baseline scenario (in relation to F-target)

Section 5: Evaluation of stock mixing scenarios and migration patterns

Section 6: Evaluation of the LTMP in relation to multi-species interactions for the Eastern Baltic cod as well as stock mixing

Section 7: Evaluation of the robustness of the LTMP to different TAC constraints

Section 8: Evaluation of robustness of the LTMP to percentage of reduction in F

Section 9: Evaluation of robustness of the LTMP to initial biomass level

Section 10: Evaluation of stock assessment model in use

Section 11: Effectiveness of effort regulation for reducing F in relation to TAC regulation

Section 12: Results based management – effectiveness of the LTMP in relation to catch quota and no discard.

16.0 FLR Model Settings in relation to Baseline (no change)

3.1 Underlying assessment and assessment model used in the FLR simulations

The FLR simulation models include and use information from the standard ICES WGBFAS 2011 assessment and input from the standard ICES SAM assessment model for the Eastern and Western Baltic cod stocks in the present applications.

A stochastic state-space model (SAM) (ICES 2011 and references herein) is used for assessment of cod in the Eastern and Western Baltic Sea. The model allows estimation of possible bias (positive or negative) in the data on removals from the stock in specific years. Settings of the model were used as specified in the Stock Annex. Details on model configuration, including input data and results can be viewed at the websites www.wbcod.stockassessment.org login:guest password:guest for the Western Baltic Cod and for the Eastern Baltic cod at www.ebcod.stockassessment.org login:guest password:guest, respectively.

In the FLR model forecast mode, the SAM stock assessment is mimicked by adding a multivariate Gaussian white noise to the 'true' population (i.e. the population simulated by the operating model) at the beginning of each year. This is a structured noise accounting for co-variance between the age-specific Ns and Fs. Each number is drawn from a multivariate normal distribution having the variance/co-variance matrix estimated by SAM (via its internal Kalman Filter procedure) during the last stock assessment (2011 here).

In the FLR stock based model, the TAC is calculated including discard, and the yield is total catch here. The TAC for the starting year i.e. 2011 is set, for the Eastern Baltic cod stock to 67 800 tons corresponding to the official TAC for 2011 i.e. 64 500 tons, added to 3 300 tons of expected discards, the latter based on prediction from 2010. For the Western Baltic cod stock, the 2011 TAC is set to 23 000 tons corresponding to 18 800 tons and 2 200 tons for expected landings and discards respectively. By contrast, the simulation of discards are explicit in the fleet based model and then the starting TACs are accounting for official TAC only i.e. 18 800 tons for the western cod stock.

In order to set the TAC at y+1 within the simulated management procedure, a short-term forecast is run each year y based on the assessed population at y-1 which is projected forward assuming recruitment and F levels. While the F levels are given by the management plan (e.g. reduction of F by 10% according to the current LTMP), the predicted recruitment assumes a running geometric mean over the last 10 years of the assessment at y.

The implementation error is when a discrepancy occurs between the actual catches and the TAC for various reasons (misreporting, etc.) The implementation error when tested was set to a CV of 0.1 based on a qualified guess which has not been altered to remain consistent with previous studies.

3.2 Population dynamic parameters

In general, the population dynamic parameters on growth, maturity and recruitment estimated and used in ICES WGBFAS 2011 have also been used in the present FLR modeling. Different parameter settings have been used for some of the scenarios in the different simulations, e.g. recruitment, in relation to evaluating the influence of biological variability impacting the effect of management and the management plan.

Initial N at age

The stock based projections start for 2011 from the 2010 N at age given by the last SAM assessment of 2011. The MP is then setting a TAC for 2012 while the TAC for 2011 is fixed at the start (see above).

The fleet based projections start for 2009 from the 2008 N at age given by the XSA last assessment of 2011. Historical F is applied on 2009 and 2010 and the simulated fleets start catching in 2011 only (notice that a preliminary run is necessary for calibration purpose allowing the fleets catching during 2009). The MP is then setting a TAC for 2012 while the TAC for 2011 is already fixed at the start (see above). The population is rigorously equivalent to the stock based approach while the starting point is earlier. The 2009 starting point is used because this is the more recent available year for the fleet-related data.

Recruitment:

Different recruitment scenarios have been used. The baseline recruitments have been the following for the two cod stocks, and have been denoted the following for given period:

Western Baltic Cod: Bad (1986-2009)/ Very Bad (1999-2009)
Eastern Baltic Cod: Bad (1999-2009)

When bad recruitment, the Hockey-stick SSB-R is used with tipping points at 85.000 and 15.000 tons in SSB for Eastern and Western cod, respectively. The Hockey-stick tipping point is at 250.000 tons in SSB for Eastern cod under good recruitment.

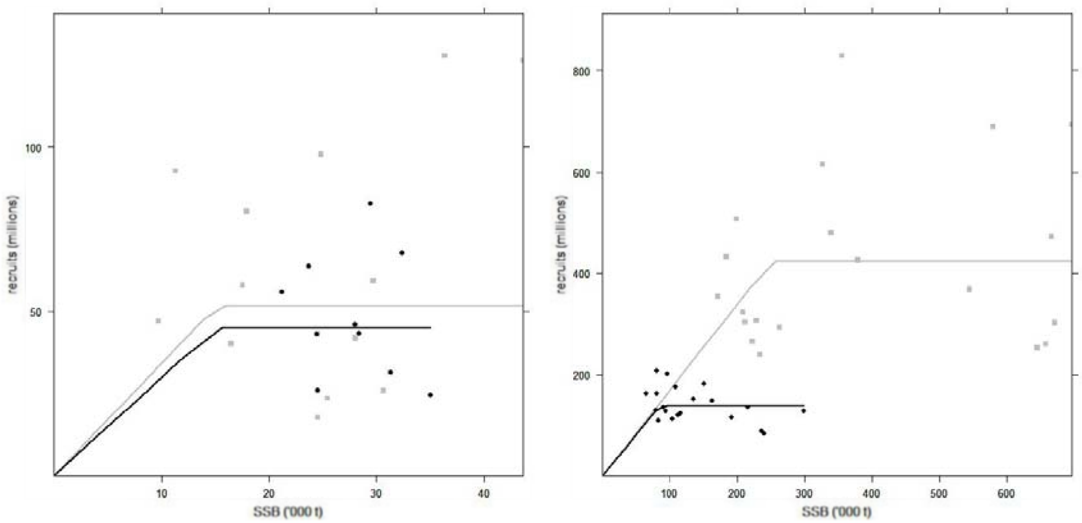

Figure 3.1 Hockey Stick SSB-R-relationships for Western Baltic cod (left) and for Eastern Baltic cod (right).

Growth, Maturity and Natural Mortality

All simulations and scenarios use the weight at age and maturity at age (maturity ogive) by stock as given in the ICES WGBFAS 2011 Report (ICES, 2011) both with the stock based and the multi-fleet based version of the FLR model.

The used biological parameters for weight at age, maturity at age, and natural mortality at age in the FLR modeling => Arithmetic means of ICES WGBFAS covering the period 2005-2010, except for the simulations including multi-species interactions for the Eastern Baltic cod, where natural mortality is not explicit (see BALMAR in Lindegren *et al.* 2009 – see section 3.3).

In the fleet-based model applied to the Western Baltic cod, The gear selectivity and the discard equation specifications require converting mid-age into fish length. For this purpose, the mean size of each age has been computed from the Von Bertalanffy growth curve using the following parameters: K_0.11386, Loo=101.135, to=-1.42793 estimated using the Ford-Walford plot on measured individuals during the KASU survey over 2008-2010.

3.3 Plug in the FLR stock-based MSE for east cod with the BALMAR statistical food-web model

The BALMAR modelling framework is a statistical food-web model (Lindegren *et al.* 2009) which has been applied and parameterized to project forward the cod, sprat and herring stock status in the Eastern Baltic Sea, accounting for the time-series of zooplankton availability, hydrographical and climate influence (salinity and temperature) and overall fishing pressure.

The added value of replacing the default FLR OM for the East cod with the BALMAR module is to account for potential species interaction effects between cod, sprat and herring, together with hydrographical and climate drivers, all factors that are usually summed up in the natural mortality component.

The required input i.e. the SSB and F for sprat and herring are provided by the last assessment for these stocks (WGBFAS 2011, Herring in SD 25-29, 32 excl. Gulf Of Riga, Sprat in SD 22-32). The BALMAR version used here is an extended version of the previously op. cit. model which now is age-structured.

3.4 Fleet-based model effort allocation parameterization

The model is applied for the Western Baltic Sea. The Year of Calibration: 2009. STECF effort data from the STECF Effort Regime has been used as provided by STECF SGMOS-10-05.

Landing data per rectangle per quarter is provided by Denmark (DEN), Germany (GER) and Sweden (SWE) in relation to present investigations and research project investigations related to e.g. the Femern Belt Science Provision Project and the EU FP7 MEECE project.

The fleet-segments included are metiers defined from combinations of countries, vessel size categories, and main gear types and mesh size categories.

Scaling factor (catchability) q in F=q*E targetFactor is calibrated for the fleet of reference comparing simulated to observed landings assuming targetFactor at 1 for this fleet. Target factor for other fleets are obtained by applying a GLM on fleet-specific cod CPUE over the period 2005-2009.

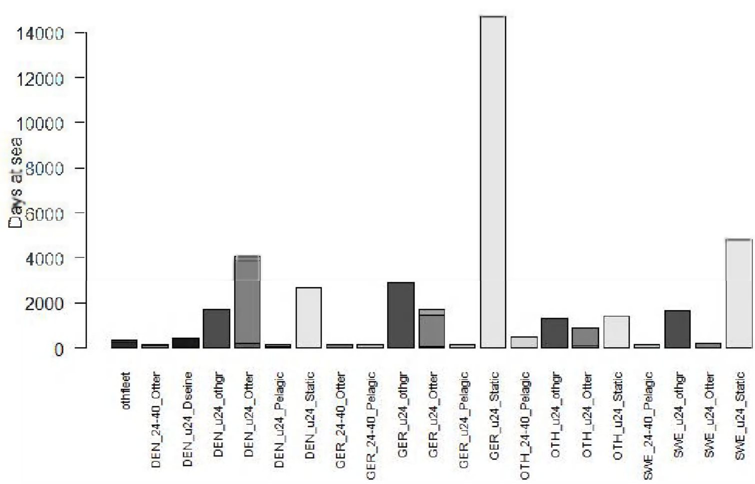

Figure 3.2. Effort in 2009 of the simulated fleet segments in the Western Baltic Sea

Table 3.1 Relative catching power for western cod obtained from a GLM on cod CPUE for getting rid of year effect, spatial effect and season effects (see Bastardie et al. 2010b)

Relative catching

	power (2005-2009)
metierothfleet_TR1	6.023836
metierGER_24-40_Otter_TR1	4.607987
metierSWE_u24_Otter_TR1	3.415169
metierDEN_24-40_Otter_TR1	2.19964
metierGER_24-40_Pelagic_OTH2	1.142151
metierDEN_u24_Dseine_TR1	1.0162
metierothfleet_nomesh	1.009615
metierDEN_u24_Otter_TR1	1
metierGER_24-40_othmet_nomesh	0.847841
metierDEN_u24_Static_nomesh	0.574111
metierGER_u24_Otter_TR1	0.52387
metierDEN_u24_othgr_nomesh	0.519104
metierDEN_u24_Otter_TR2	0.454818
metierDEN_u24_othmet_nomesh	0.361903
metierSWE_u24_Static_nomesh	0.332824
metierSWE_u24_othgr_nomesh	0.243899
metierGER_u24_Pelagic_OTH2	0.223567
metierDEN_24-40_othmet_nomesh	0.162919
metierDEN_u24_Pelagic_OTH1	0.158607
metierSWE_24-40_Pelagic_OTH2	0.148297
metierGER_u24_Static_nomesh	0.131044
metierGER_u24_othmet_nomesh	0.125334
metierGER_u24_Otter_TR3-2	0.112942
metierGER_u24_othgr_nomesh	0.089394

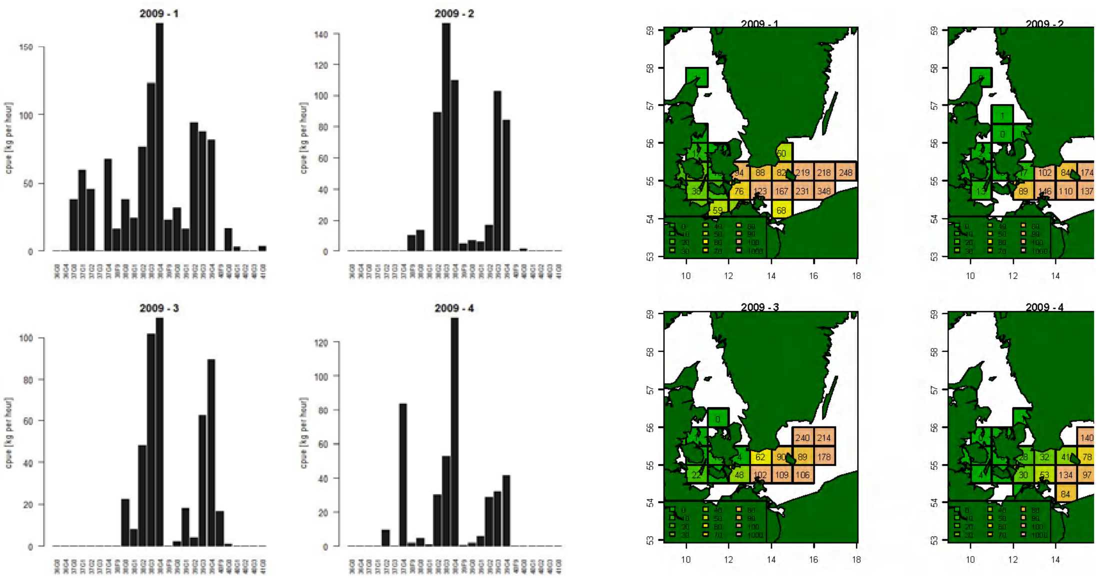

Figure 3.3 Left: CPUE (kg per hour) in the year 2009 per quarter 1 to 4 in the Western Baltic Sea ICES rectangles for the fleet of reference DEN_u24_Otter_TR1 (i.e. used for the calibration of the scaling factor q). Right: map of CPUE (kg per hour) for the fleet of reference within Kattegat, Western Baltic Sea and Eastern Baltic Sea areas.

3.5 Informing the FLR simulations with underlying cod resource availability in time and space (for the fleet based version of the model)

The underlying resource availability of cod in the Western Baltic Sea informing the fleet based FLR model applied for Western Baltic cod has been obtained with high spatial and seasonal resolution from output from the advanced Log Gaussian Cox Process (LGCP) statistical model to link survey time series, evaluate trawl survey catchability, and to estimate unbiased fish distribution, density, and abundance patterns with high precision (Lewy and Kristensen, 2009; Kristensen *et al.*, 2006). This LGCP model takes into account spatial correlation between observations, zero observations, over-dispersion, and potential correlation between different fish age and length groups (cohorts). From this model, it is possible to predict and interpolate unobserved densities at any location and season of year in the area for cod (*Gadus morhua*). The LGCP model was informed by up-dated ICES STECF data including quarter 1 and quarter 4 2010 observations, and output from the runs of the LGCP model by ICES Statistical Square and Month during the period 2005-2010 was used in the FLR modeling. Output data on relative distribution of cod by area and season for 2009 has been used to calibrate the FLR models used in the present simulations and management evaluation.

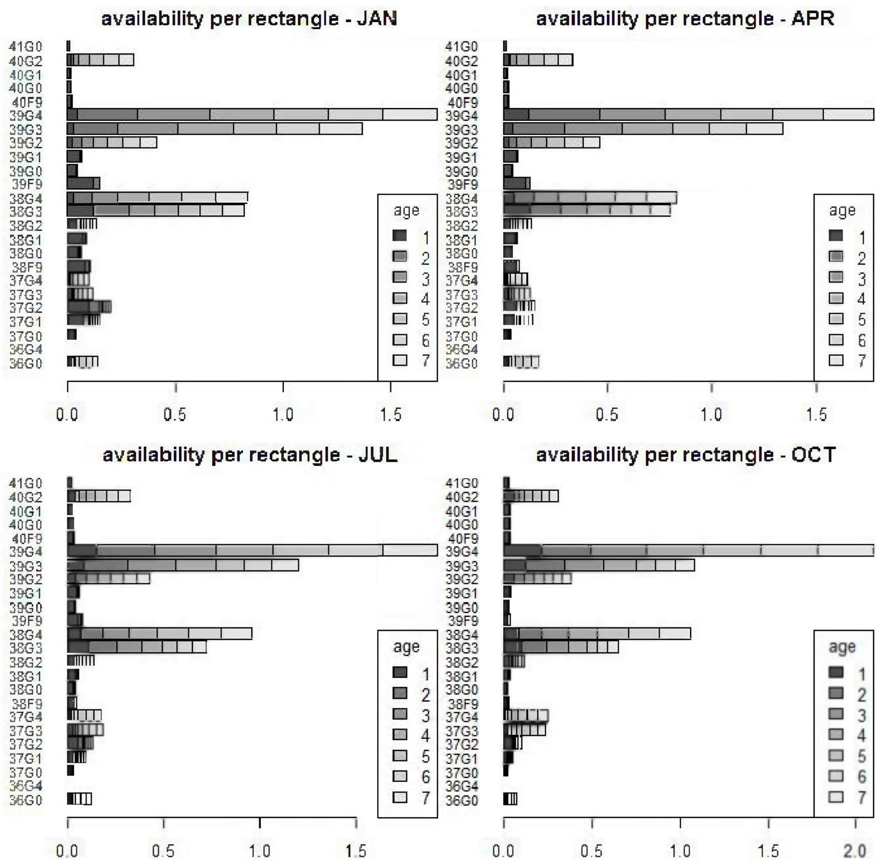

Figure 3.4. Relative cod availability per ICES rectangle per age within the Western Baltic area given by the the LGCP model (see the text) for 4 selected months in 2009. The proportion per age sums up to 1 across the rectangles for a given month.

3.6 Discard parameters and discard ogive

The discard rates by age for respectively Eastern and Western Baltic cod have been used as given in ICES WGBFAS (2011) and implemented in the simulations with the combined fleet based management evaluation model (Bastardie *et al.* 2010b) applied with up-dated data for the Western Baltic Sea. For the combined fleet-and-stock-based model the F and Yield are divided according to landings, discard, and selectivity, i.e. where both a discard and a selectivity ogives are applied.

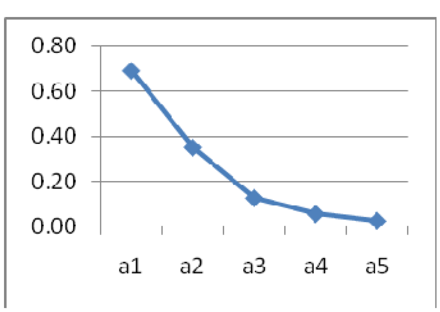

Figure 3.5. Proportion of discards in catch by age (average 2005-2010) for the Western cod stock.

The discard ogive is not in use for the stock based model applied in the Eastern and Western Baltic Sea as this model application use the assessed exploitation pattern given by use a F-multiplier directly including discard and selectivity (see Bastardie et al., 2010a). Hence, the FLR stock based model calculates the TAC including discard, and the yield is total catch here. The fishing mortality by age used as input in the FLR model from the ICES WGBFAS includes discard. However, the TAC from the WGBFAS is only based on landings.

3.7 Selectivity parameters and selection ogive

Selectivity parameters and according selection ogives have been obtained from SGMOS 10-06b for towed (active) gears, e.g. trawls and seine, where the parameters for the BACOMA 110 mm demersal trawl have been used for all the international trawl and seine fleets during the period up to and including 2009. In 2010 new technical measures and mesh size have been implemented for trawls (active gears). Here the mesh size was changed to 120 mm both in the BACOMA (to BACOMA 120) and in the T90 trawl by 1st January in SD 22-24 and by 1st March in SD25-32, i.e. the BACOMA exit window was increased from 110 mm to 120 mm to minimize discards. Previously, (2009 and before), there might have been a tendency towards higher degree of use of BACOMA 110 in the Baltic cod fisheries except for in Poland, but for 2010 there are indications that more fishermen have transferred to T90, which probably is the dominant gear today in the Baltic cod fishery (BACOMA 120 mm) (Niels Madsen, DTU Aqua, Pers. Comm., Madsen (2007). The gillnet selection parameters, i.e. selection parameters for passive gears, have been obtained from documentation provided by Niels Madsen, DTU Aqua, based on the gillnet selection parameters published in Holst *et al.* (2002) and on Madsen (2007). These selection parameters covers the most frequently used gillnet mesh sizes in the Baltic Sea used for all international gillnet fleets.

The used selection parameters in the simulations according to the above documentation is presented in Table 3.1 The selection parameters used for active gears represent an average of of BACOMA and T90 for 110 mm for 2009 and previously and an average of BACOMA and T90 for 120 mm from 2010 and onwards. The selection parameters used for passive gears represents the selection of a 110 mm gillnet up to and including 2009, while it represents the selection of a 120 mm gillnet from 2010 and onwards.

Table 3.2. Selectivity parameters used in the fleet based model to inform the selectivity ogive.

Gear	Selectivity parameters (cm)		
		2009	>2009
Active	L75	41.25	44.6125
	L50	38.775	41.35
Passive	L75	51	51
	L50	49.5	49.5

The selectivity parameters have been applied for the combined fleet-and-stock- based model in the Eastern and Western Baltic Sea. The selection ogive is not used in the fleet based model as explained under section 3.5 as well as sections 2 and 3.1.

3.8 Fleet-based economy parameterization

Prices and costs

17.0 Baseline scenario (in relation to F-target)

The baseline scenarios with different recruitment levels (bad and very bad recruitment for the Western Baltic cod and bad and good recruitment for the Eastern Baltic cod) uses the assessment output from the SAM model with the median (while scenarios with the SAM upper and lower confidence limits are shown in a separate section).

The baseline scenarios have a F-target of 0.6 for the Western Baltic cod stock corresponding to present F-target used by ICES WGBFAS and in the present EU Fisheries Management under the LTMP. Scenarios with different levels of F-target (0.6 and 0.35) for the Western Baltic cod have been evaluated in the simulations both with the stock-based and the multi-stock-multi-fleet-based version of the model, while F-target for the Eastern Baltic cod has been kept at F-target=0.3 in the simulations.

West / East

Baseline 1 (green) vs Baseline 2 (red): differ recruitment: bad vs. really bad

Baseline 1 (green) vs Baseline 2 (red): differ recruitment level: bad vs good

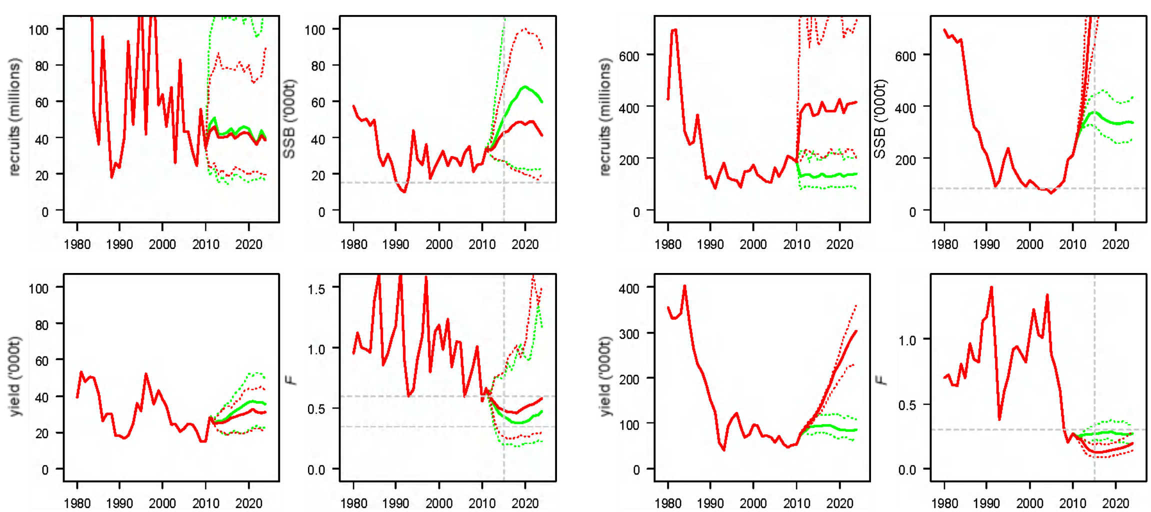

Figure 4.1 Baseline scenarios with different recruitment levels. TAC constraint 15%, reduction of F by 10%, SAM Model, F-target (west) 0.35 and 0.6, F-target (east) 0.3.

The results indicate that for both stocks a better recruitment regime led to higher yield and stock levels, even to an unrealistic level for the Eastern Baltic cod under good recruitment conditions, while the target F is overshoot.

West: Baseline 2 (green) vs 13 (red): difference in
0.6 vs 0.35

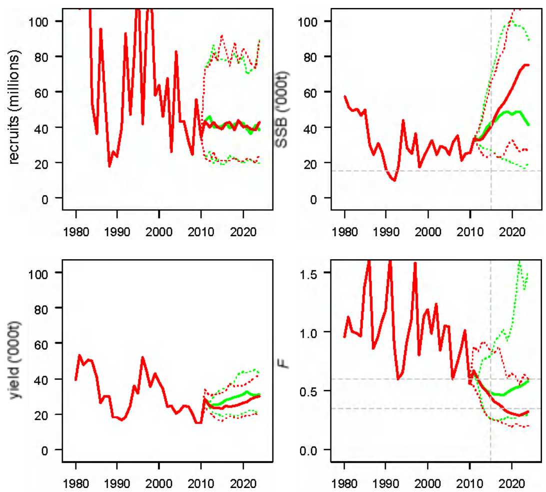

Figure 4.2 Baseline scenarios with different F-target levels. Recruitment WBC: really bad, TAC constraint 15%, reduction of F by 10%, SAM Model. In the red (13) implCV=0.1.

The results indicate that a F target of 0.6 enable the stock to recover at historical level with a high certainty while a Ftarget at 0.35 led to even a better result while the median yield is slightly lower in this last case. The results indicate that with a F-target of 0.35 the SSB will increase to levels well beyond historic levels.

West / East
Baeline 2 (green) vs 5 (red): implCV at 0 vs implCV Baseline 1 (green) vs 5 (red): implCV at 0 vs implC

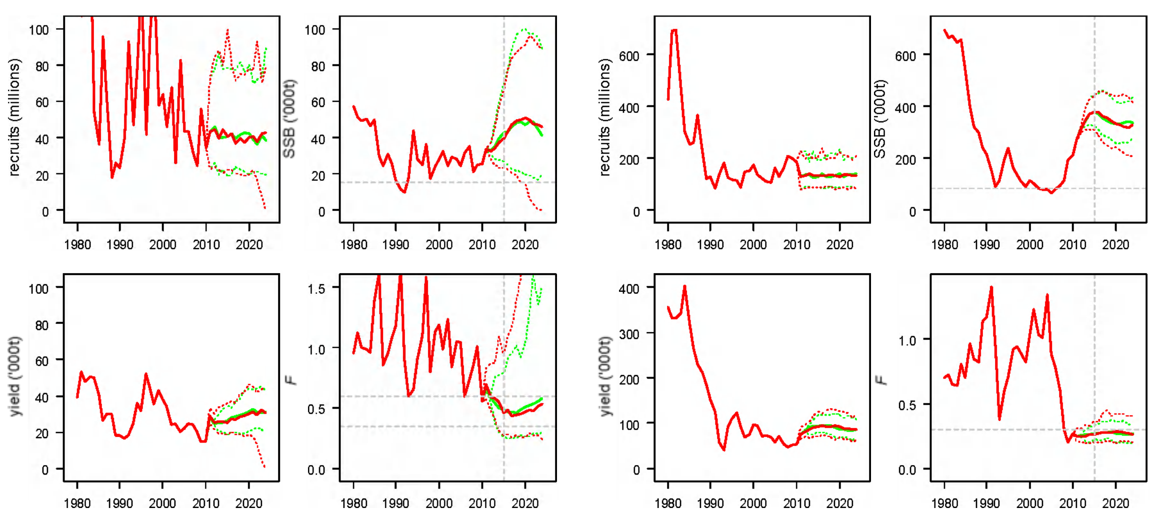

Figure 4.3 Baseline scenarios with different implementation CVs. F-target levels: 0.6 (WBC) and 0.3 (EBC). Recruitment WBC: really bad and EBC: good/bad, TAC constraint 15%, reduction of F by 10%, SAM Model.

The results indicate that for the Western Baltic cod, the implementation error increased the uncertainties of future stock projection while the success of the plan is not changed in average (a few trajectories may have led to failure, however). This error does not seem significant for the Eastern Baltic cod at least not at the tested level of 0.1.

18.0 Evaluation of Stock mixing scenarios and migration patterns

The sensitivity of the management plan has been evaluated to different levels of stock mixing and migration between the two Baltic cod stocks. Different scenarios of mixing/migration have been applied based partly on information from recent scientific reviewing of literature and tagging studies (e.g. Hussy, 2011, in press IJMS) as well as based on information from recent preliminary analyses of frequency distributions of otolith types by area (ICES WGBFAS 2011).

The fishing mortality corresponding to maximum sustainable yield (F_{MSY}) that is currently defined by ICES is substantially lower than the management plan target, and would correspond to a very different management advice. However, determining F_{MSY} for this stock is problematic, partly because the fishing mortality during most of the historical time-series is estimated to have been very high, while the biomass has been relatively stable, and the relationship between the estimated spawning stock biomass and recruitment is unrealistic. This could be due to mixing between the Eastern and Western Baltic cod stocks, which at present is not taken into account in stocks assessments. Such mixing will affect directly the estimates of stock biomasses and fishing mortalities in the assessments and forecasts, and can if significant result in a wrong perception of stock level, exploitation pattern and level as well as recruitment.

The Eastern and Western Baltic cod stocks have historically been assessed separately but has been managed as a single stock under a common TAC. ICES has continuously advised that the two stock should be managed separately to allow stock specific regulation measures be implemented differently in the two areas. This measure was fully implemented for the first time in 2005.

Mixing of stocks in the Eastern and Western Baltic is taking place. There are indications that the Eastern component in the Western Baltic area is important (maybe 20-30%**).** The stock size of Eastern Baltic cod has increased in recent years, although the oxygen conditions in northeastern areas in the Baltic are indicated to be poor (ICES, 2011). Thus, the expansion of cod to northeastern areas, which took place in former times with high eastern Baltic stock size, may be prevented in present time due to hydrographic conditions. In previous decades, the volume of water with anoxic or hypoxic conditions has also been relatively large, for example in the 1980s, though not as pronounced as in recent years (ICES, 2011). The fishery in the Western Baltic is currently taking place mainly in SD 24, with intensive fishery close to the border to SD 25. The proportion of SD 24 in cod landings in the Western Baltic is currently among the highest observed in the entire time series from 1965-2010 (ICES, 2011). The only period observed in the past when the proportion of cod landings in SD 24 was at a similar high level was in mid-1980s. In this period, cod in the eastern Baltic was also at a high level, while the hydrographic conditions in the central Baltic became poorer. This situation is relatively similar to the recent years. (ICES, 2011). Thus, it could be hypothesized that the proportion of Eastern stock component in the Western Baltic area is increasing in situations when the Eastern stock is high and hydrographic conditions in the central Baltic are poor which might prevent stock expansion to the northeastern Baltic. In such a situation, migration to the Western Baltic area could be expected. (ICES, 2011).

The proportion of cod in the Western Baltic area, potentially originating from the Eastern Baltic, was preliminary investigated in 2010 based on ICES and EU EWG work using Danish otolith samples from SD 24, in 2 areas in the western Baltic 1) close to the border to SD 25 and 2) in western part of SD 22. The otoliths of cod belonging to the Western stock are generally considered to be easier to read, whereas it is considered to be difficult to read the otoliths of the Eastern Baltic cod. In Danish samples, the classifications from A to D relate to the degree of difficulty in age-reading a particular otolith. The categories A and B refer to easily readable otoliths, the categories C and D indicate that a particular otolith is difficult to age-read, which might indicate that a particular individual is originating from the Eastern stock. The proportion of otoliths classified as difficult to read (C and D) in ICES square 38G4 (SD 24, close to the border to SD 25) was between 20 and 40 percent in 2010 (Table 5.1), and was generally higher for older ages compared to the younger age-groups. For comparison, in ICES square 38G0 (SD 22), the proportion of otoliths which were classified as difficult to read was around 10 percent. These results are, however, uncertain as they are based on these initial pilot investigations only using a limited material and the types of otoliths are only indicating the stock affiliation.

Table 5.1. The number of otoliths in Danish samples from ICES squares 38G4 and 38G0 and the proportion of otoliths classified as difficult to read (C+D), which is generally characteristic for otoliths originating from the eastern Baltic.

ICES square 38G4						
	Otolith index					
Age	A	B	C	D	Total	Proportion of C+D
2	18	20	9	1	48	0.21
3	44	82	29	8	163	0.23
4	47	161	73	18	299	0.30
5	9	84	44	11	148	0.37
6	7	23	14	3	47	0.36
7	2	20	9	1	32	0.31

ICES square 38G0						
	Otolith index					
Age	A	B	C	D	Total	Proportion of C+D
1	96	12			108	0.00
2	103	52	13	4	172	0.10
3	45	49	19	1	114	0.18
4	26	19	6		51	0.12
5	9	18	2		29	0.07
6	3	5			8	0.00

The proportions in Table 5.1 have been converted into the proportion of eastern Baltic cod by age migrating into the western Baltic by using the proportion of stock numbers at age in SD22-24 and SD25-32, respectively, from the ICES WGBFAS 2011 assessment to calculate this migration when applying the above proportions. The resulting migration pattern evaluated in the first scenario is presented in Table 5.2 below.

Table 5.2 Eastern Baltic cod migration ogive calculated from the assumed proportion of Eastern cod residing within the Western Baltic and the Ns at age from the last WGBFAS 2011 assessment.

Age	N_2010 wcod	Proportion of ecod within wcod	N_2010 ecod	
2	18732	0.23	198515	0.021703
3	14945	0.23	159593	0.021538
4	9757	0.23	114233	0.019645
5	3033	0.35	56103	0.018921
6	802	0.35	17910	0.015673
7	321	0.35	8745	0.012847

Another scenario of migration rates between SD24 and SD25 has been evaluated with estimations based on indications in:

- STECF report "Report of the Sub Group on Management Objectives and Strategies (SGMOS 10-06). Part e) Evaluation of multi-annual plan for Baltic cod", Figure K.3
- Bleil and Oeberst (2004) Comparison of spawning activities in the mixing area of both the Baltic cod stocks, Arkona Sea (ICES Sub-division 24), and the adjacent areas in the recent years. ICES C.M. 2004/L:08
- See also Hussy (accepted, 2011).

The results of this analysis are shown in Table 5.3.

Table 5.3 Estimates indicate the percentage contribution of one stock to the other, i.e. a "0.1" for East to West means, that 10% of the Western stock which originally come from the East.

Age class	East to West	West to East
0	0.100	0
1	0.100	0
2	0.092	0.008
3	0.092	0.008
4	0.092	0.008
5	0.092	0.008
6	0.092	0.008
7	0.092	0.008

This estimation of migration rates is based on the assumption that spawning time is stock specific. Thus, the percentage of the maturity patterns in March/April (Western) and June (Eastern) represents the component of one stock in the others management area. This total percentage was divided equally between age classes.

These estimates are, however, also uncertain and associated with a series of problems:

- It is questionable whether spawning time is in fact genetically determined. Even in genetically distinct stocks of e.g. herring, it is well known that environmental conditions and behavior have a huge impact on timing.
- Feeding migrations out of the spawning areas are not accounted for, thus the migration rates may be overestimated
- Not possible to separate immature/resting/spent individuals, which may lead to underestimation of migration
- Juveniles (age groups 0 and 1): This is just an assumption, based on the probability that juveniles originating from Eastern parents, but spawned in the West, probably stay in the West. But a portion of these may be transported back to the Bornholm sea as eggs/larvae

Similar to the proportions in Table 5.1, then the proportions in Table 5.3 have been converted into the proportion of eastern Baltic cod by age migrating into the western Baltic by using the proportion of stock numbers at age in SD22-24 and SD25-32, respectively, from the ICES WGBFAS 2011 assessment to calculate this migration when applying the above proportions. The resulting migration pattern evaluated in this scenario is presented in Table 5.4 below.

Table 5.4. Eastern Baltic cod migration ogive calculated from the proportion documented in the Table 5.3 of east cod residing within the West Baltic and the Ns at age from the last WGBFAS 2011 assessment.

Age	N_2010 wcod	Proportion of ecod within wcod	N_2010 ecod	
2	18732	0.092	198515	0.008681
3	14945	0.092	159593	0.008615
4	9757	0.092	114233	0.007858
5	3033	0.092	56103	0.004974
6	802	0.092	17910	0.00412
7	321	0.092	8745	0.003377

Simulations have been performed with these two migration scenarios (one from literature review and one from otolith analyses) compared to the initial one performed and presented under SGMOS 10-06.

West / East

Baseline 2 (green) vs 3 (red): really bad, non-coı coupled (otolith)

Baseline 1 (green) vs 3 (red): bad, non-coupled vs (otolith)

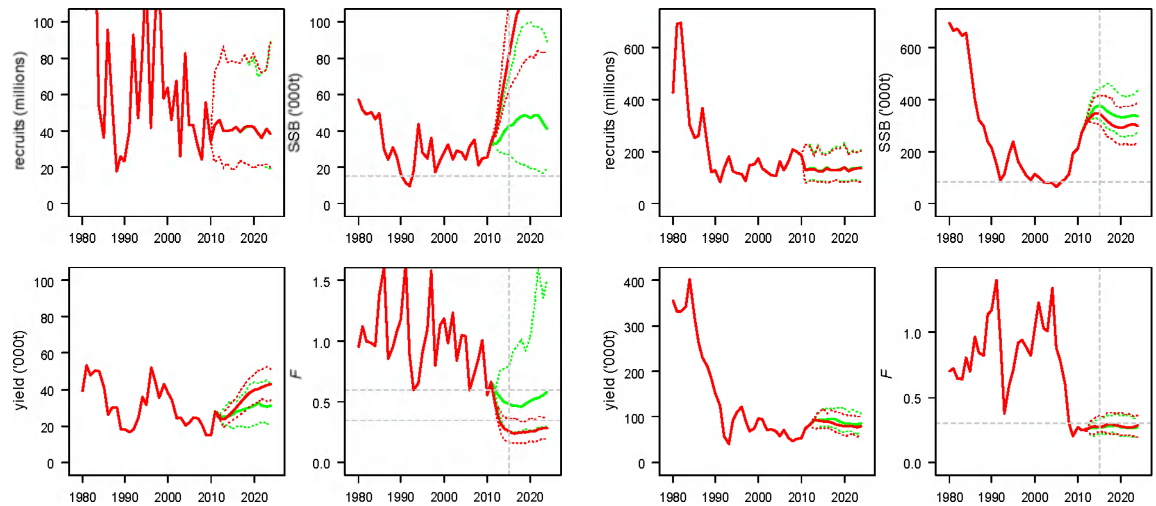

Figure 5.1 Impact evaluation of a migration and mixing scenario from otolith analyses with the two cod stocks coupled compared to the baseline. Recruitment WBC: really bad and EBC: bad, TAC constraint 15%, reduction of F by 10%, SAM Model.

The results indicate that for the first tested migration ogive of Eastern Baltic cod to the West based on otolith analyses greatly impact the Western stock by lowering down the F to unexpected low level leading to a stock unrealistically high and hitting the ceiling. By contrast the loss of individuals for the Eastern Baltic cod (east side) has only very low effect on the Eastern cod stock trajectory.

West / East

Basel. 2 (green) vs 16 (red): really bad, non-coı coupled (literature review/SGMOS-10-06)

Basel. 1 (green) vs 16 (red): bad, non-cou coupled (literature review/SGMOS-10-06)´

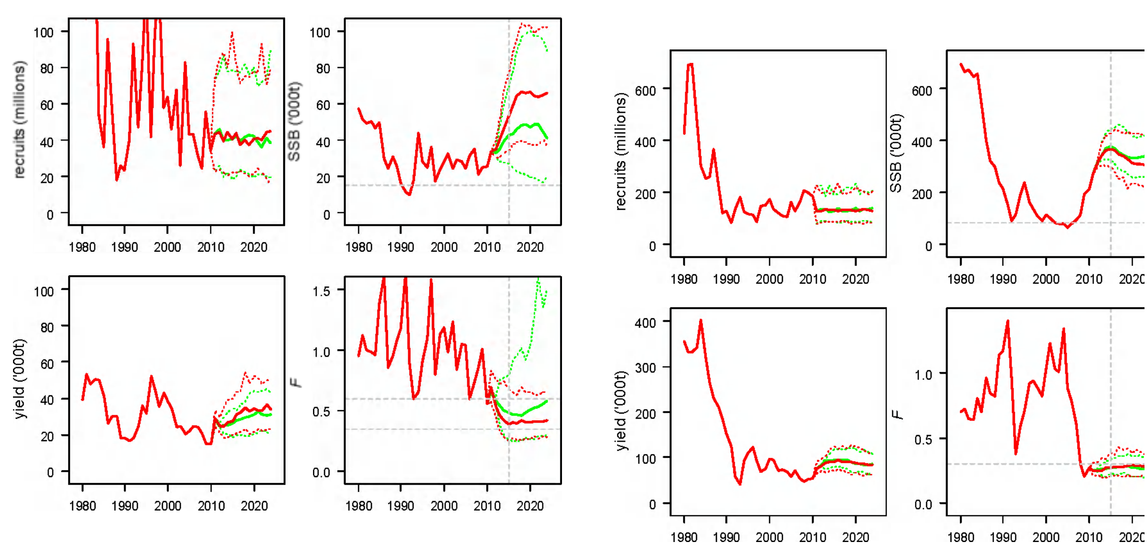

Figure 5.2 Impact evaluation of a migration and mixing scenario from literature review / SGMOS-10-06 with the two cod stocks coupled compared to the baseline. Recruitment WBC: really bad and EBC: bad, TAC constraint 15%, reduction of F by 10%, SAM Model.

The results indicate that for the Western Baltic cod, the second tested migration ogive of Eastern cod to the west led to the same tendency as for the previous tested ogive i.e. lowering down the F, but the Western stock is reaching a more comparable level to the highest historic levels observed within the tested period. The loss of individuals for the Eastern Baltic cod has also practicallyno effect on the Eastern Baltic cod stock trajectory.

19.0 Evaluation of the LTMP in relation to multi-species interactions for the Eastern Baltic cod as well as stock mixing

Simulations in relation to multi-species considerations under the scenario of strong migration and mixing (otoliths) have been performed. The multi-species interactions for the Eastern Baltic cod is included from the BALMAR model as published in Lindegren *et al.* (2009) – see also Section 3 for explanation of the multi-species interactions evaluated with BALMAR.

East/ East
1 (green) vs 12 (red): Baseline vs. Balmar

1 (green) vs 19 (red): baseline, vs Balmar + migı west (literature rev./SGMOS-10-06)

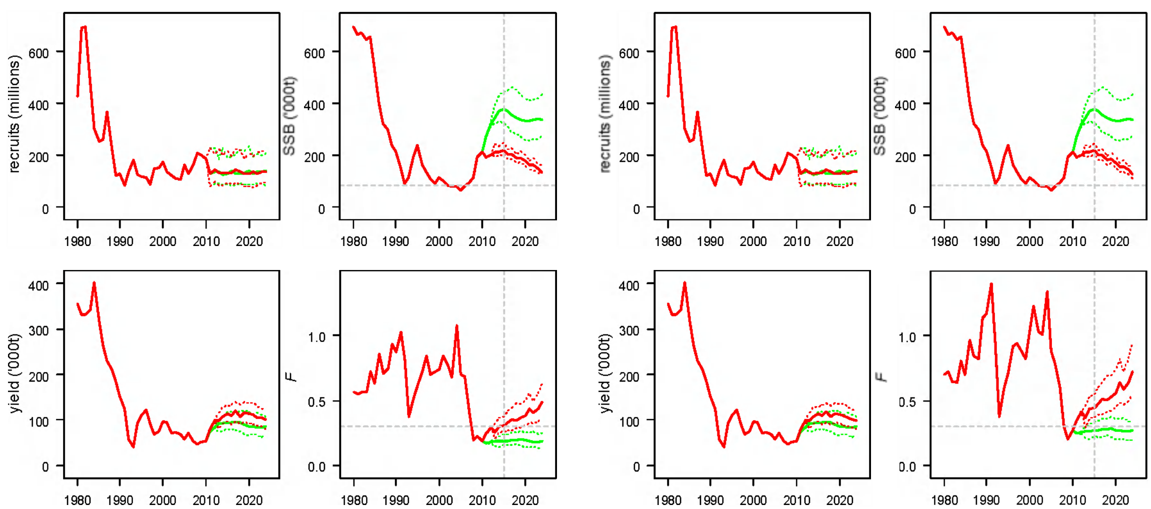

Figure 6.1 Impact evaluations of a integrating multi-species interactions for the Eastern Baltic cod. Recruitment EBC: bad, TAC constraint 15% / 30%, reduction of F by 10%, SAM Model, impl.CV=0.1.

The results show that the stock evolution in a species interaction context (with herring and sprat) is quite different compared to the baseline as the F is not able to stay at the F target of 0.6 and the SSB is approaching a plateau before declining. The increased trend in F is explained in the simulations by the over-optimistic single species short-term forecast (included in the Management Procedure) that led to decide on sequential higher TAC than necessary according to the population evolution impacted by the pelagic stocks. The migration of some individuals to the West is not making this situation worse because it has no effect on the Eastern Baltic cod stock trajectories.

20.0 Evaluation of robustness of the LTMP to different TAC constraints

Here an evaluation of robustness of the management plan to different TAC constraints has been made with respect to influence of TAC constraints in change of TAC (established for economic reasons) with respect to the regulation. Different simulation scenarios are presented for release of different TAC constraints (15%, 20%, 30%). Several questions are addressed in this context: i) Given change of constraints under the situations of different biomass levels, how robust are the constraints in relation to high or low initial biomass? ii) Should a TAC constraint be biomass level dependent? iii) How often are larger increases followed quickly by declines in stock given different constraints (does it occur at all) ?

According to the current LTMP: active TAC constraints when F<0.6 for east cod and F<1.0 for west cod.

West/ East

5 (green) vs 6 (red) vs 7 (blue): 15,20,30%   5 (green) vs 6 (red) vs 7 (blue): 15,20,30%

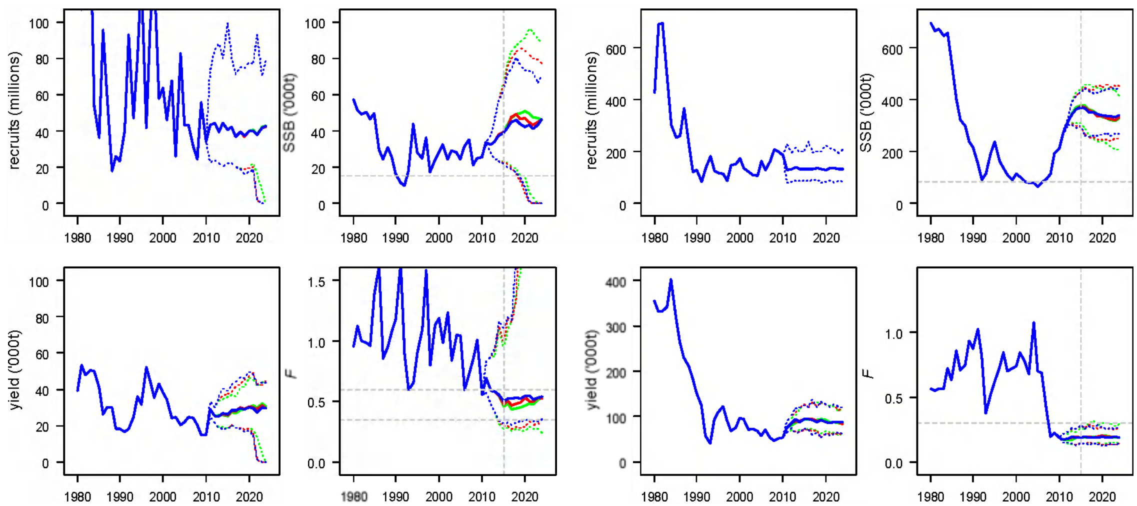

Figure 7.1 Impact evaluation of different TAC constraints with scenarios of different constraint levels. Recruitment WBC: really bad and EBC: bad, F-reduction of 10%, Impl.CV.=0.1, SAM Model.

The results indicate that the choice of the amplitude of the TAC change from a year to the next had almost no effect in the simulations for both stocks.

West/ East

8 (green) vs 9 (red) vs 10: 15,20,30% + migration fr (otolith)   8 (green) vs 9 (red) vs 10: 15,20,30% + migration fr (otolith)

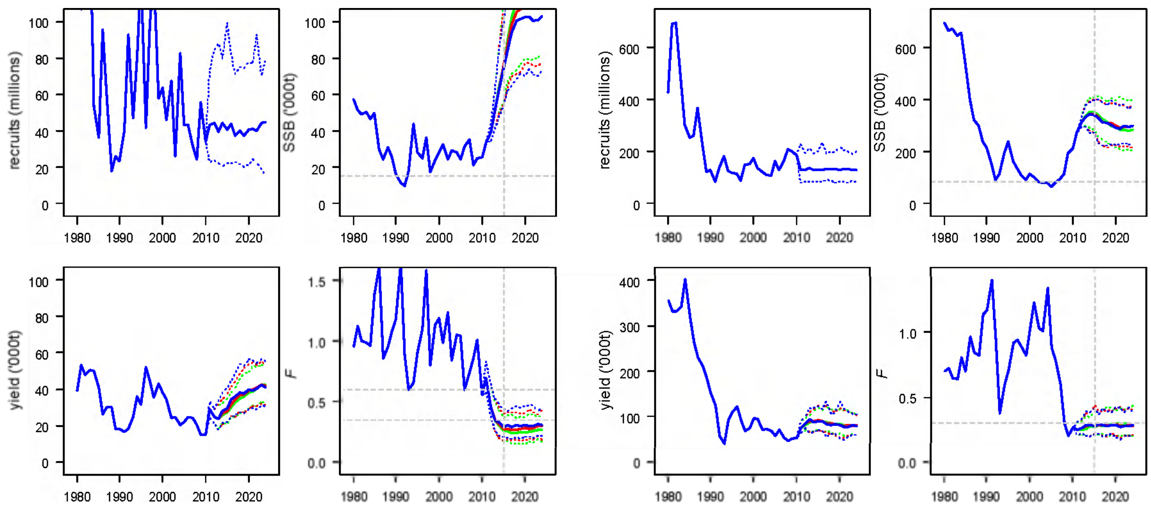

Figure 7.2 Impact evaluation of different TAC constraints with scenarios of different constraint levels including migration. Recruitment WBC: really bad and EBC: bad, SAM Model, F-reduction by 10%, Impl.CV=0.1, stock coupled model.

The results indicate that the effect of the migrations are overwhelming for all the various tested TAC changes, i.e. the TAC constraints at various levels have no comparable effect compared to the migration effect on the LTMP (see also under Section 5).

West: 8 (green) vs 9 (red) vs 10: 15,20,30% F target

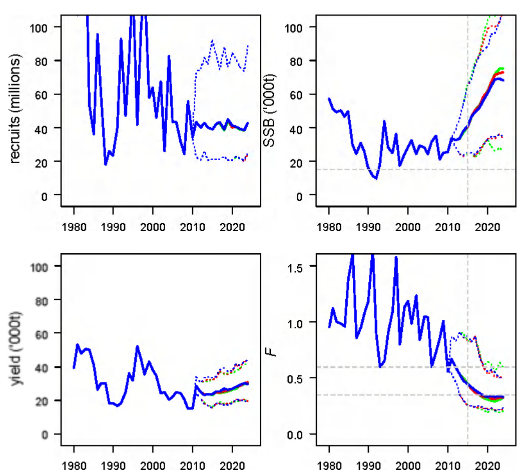

Figure 7.3 Impact evaluation of different TAC constraints with scenarios of different constraint levels including migration. Recruitment WBC: really bad and EBC: bad, SAM Model, F-reduction by 10%, Impl.CV=0.1, stock coupled model.

The results indicate that the various tested TAC changes for the Western Baltic cod stock are rather insensitive to the different tested F target levels.

8 (green) vs 9 (red) vs 10: 15,20,30% F target at 0. baseline (black) vs. 30 percent bound (grey)

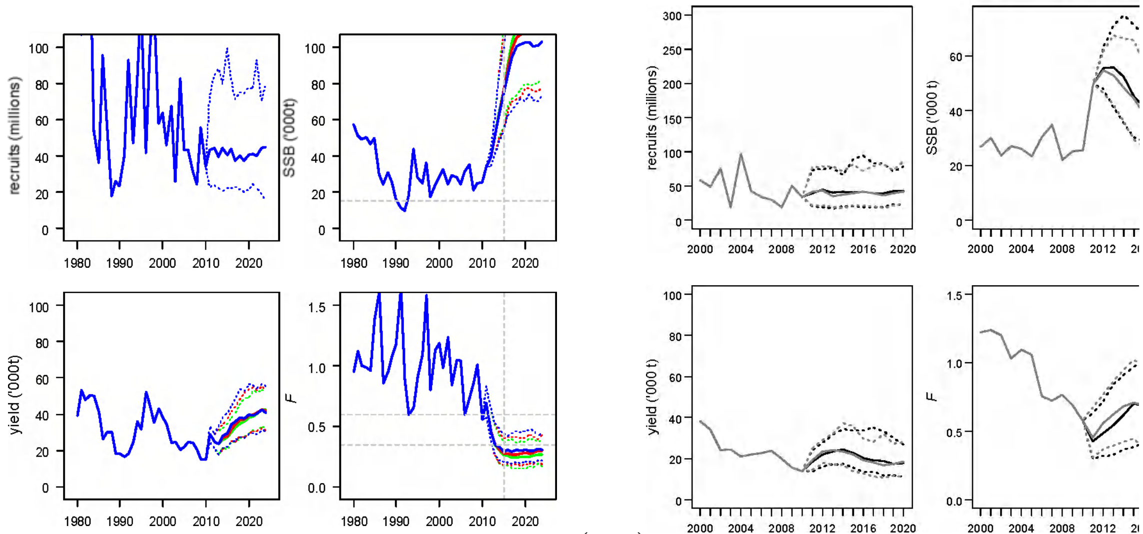

Figure 7.4 Impact evaluation of different TAC constraints with scenarios of different constraint levels for the Western Baltic cod stock (under the 'really bad' recruitment regime) using the stock based model (left), or the fleet-based model (right).

For both version of the model (stock-based and fleet-based) the results indicates minor effect of the TAC restriction within +/- 30% compared to the baseline at +/- 15%

21.0 Evaluation of robustness of the LTMP to percentage of reduction in F

West/ East

5 (green) vs 11 (red) vs 12 (blue): reduction by 10% v …
reduction by 15%

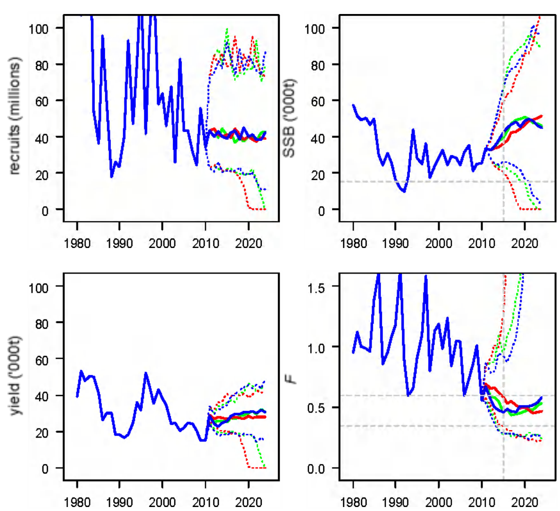

Figure 8.1 Impact evaluation of different reduction levels in F. Recruitment WBC: really bad and EBC: bad, TAC constraint 15% / 30 %, SAM Model, F-reduction by 10%, Impl.CV=0.1, stock coupled model.

The sensitivity of the management plan has been evaluated in relation to different levels of reductions in fishing mortality. Different scenarios of F-reduction covering status quo (0% reduction), 10% F-reduction, and 15% F-reduction have been tested with respect to robustness of the LTMP.

The results indicate that compared to the baseline at 10% reduction in F every year when setting the next TAC, a F reduction of 15% had a minor impact by slightly reducing the uncertainties around the median projection, but mainly due to larger decrease in F than necessary. The status quo scenario, i.e. 0% decrease in F still led to a decreased F which might be artificial in the sense that few failures led to 0 catch trajectories then lowering down the median, but with a wider range of uncertainties.

22.0 Evaluation of robustness of the LTMP to initial biomass level

The management evaluation scenarios here evaluate the robustness of the LTMP to high or low initial biomass levels for the two Baltic cod stocks according to the upper and lower confidence intervals of the SAM assessment model used by ICES WGBFAS (ICES, 2011)..

West/ East

17 (green) vs 18 (red) : SAM upper vs SAM lower   17 (green) vs 18 (red) : SAM upper vs SAM lower

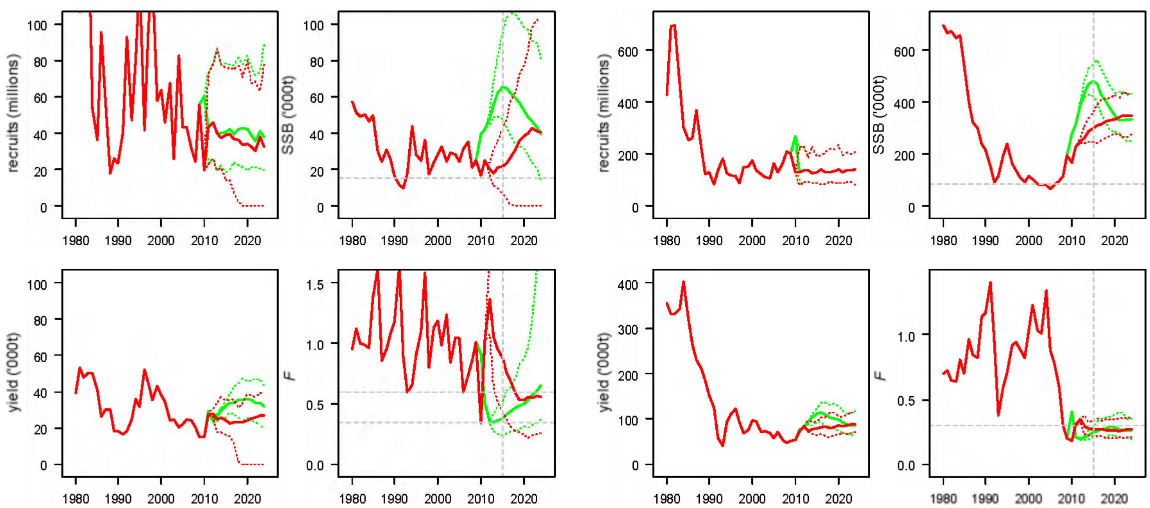

Figure 9.1 Impact evaluation of different initial stock biomasses. Recruitment WBC: really bad and EBC: bad, TAC constraint 15%, SAM Model, F-reduction by 10%.

The results indicate that the effect of starting population appears significant for both stocks and especially for the Western Baltic cod stock. For the latter stock, unsuccessful trajectories when using the lower bound of the confidence interval given by the SAM estimates led to very high Fs which lowered down the stocks and sometimes made the model unable to solve the TAC equation (the 0 catch trajectories).

23.0 Evaluation of the stock assessment model in use

The XSA model is not in use for the Western Baltic cod since 2010 as the SAM is now the official assessment model for estimating the population. By contrast the XSA is still the reference for the Eastern Baltic cod while SAM is given as secondary assessment. The robustness of the LTMP is tested against this two assessment models, albeit the XSA model is run here without shrinkage on F which is not the current setting in the WGBFAS (i.e. fse=0.75).

West/ East

2 (green) vs 20 (red) : SAM vs XSA no shrinkage   17 (green) vs 18 (red) : SAM vs XSA no shrinkage

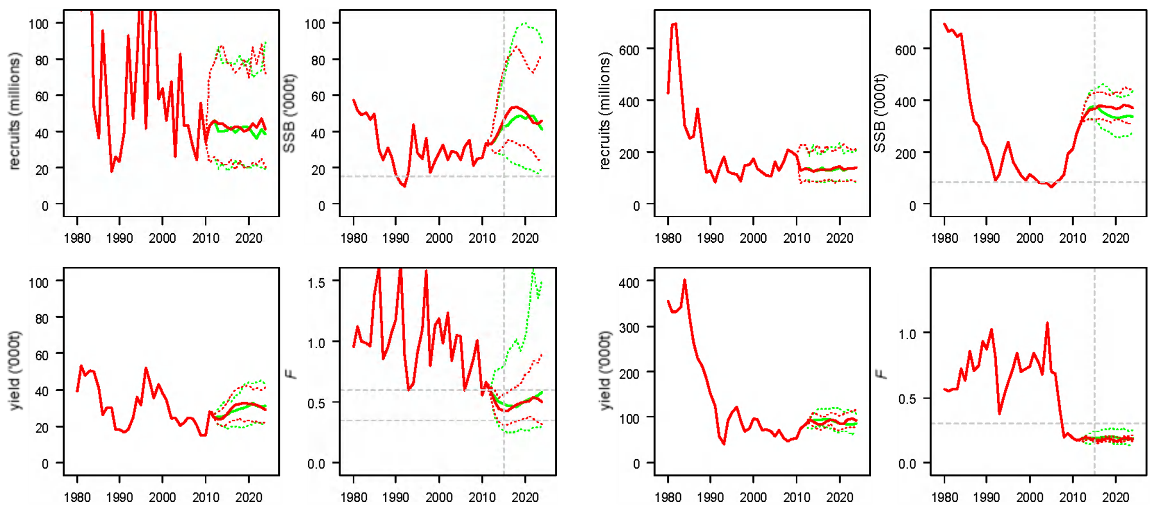

Figure 10.1 Impact evaluation of different stock assessment model in use. Recruitment WBC: really bad and EBC: bad, TAC constraint 15%, XSA Model with no shrinkage on F, F-reduction by 10%.

The results indicate that the effect of using the XSA model instead of the SAM model is moderate and mainly consist of reducing the uncertainties of the projection, providing that the shrinkage on F is not in use.

24.0 Effectiveness of effort regulation for reducing F in relation to TAC regulation

Here we are testing the relative effect of the TAC and the effort control regime required to make explicit the effort allocation into the simulations between fleets, gears and areas. While the stock-based model is not able to achieve this assessment, we developed a fleet-based model accounting for effort allocation (and reduction according to the plan) between countries, fleets and spatial and temporal heterogeneous practices. The simulations in this section cover evaluation of different management instruments such as TAC regulation under given relative annual variability constraint either alone or together with effort regulation, as well as effort regulation alone (also under given constraint) and results based management including TAC regulation under a catch quota system. This type of simulations have been performed with a multi-fleet-single-stock version of the model including all international DCF métiers (fisheries) but only applied for the Western Baltic cod stock (one stock) and management area in present context. This modeling is performed on a highly disaggregated seasonal and spatial scale using the spatial and seasonal explicit application of the FLR model published in

Bastardie *et al.* (2010b) and which has been up-dated with information from among other ICES WGBFAS 2011 (ICES 2011) as well as up-dated fisheries information from the EU STECF effort evaluation working group and also with information from EU STECF SGMOS 10-06 (Simmonds *et al.*, 2010).

11.1. **Baseline**

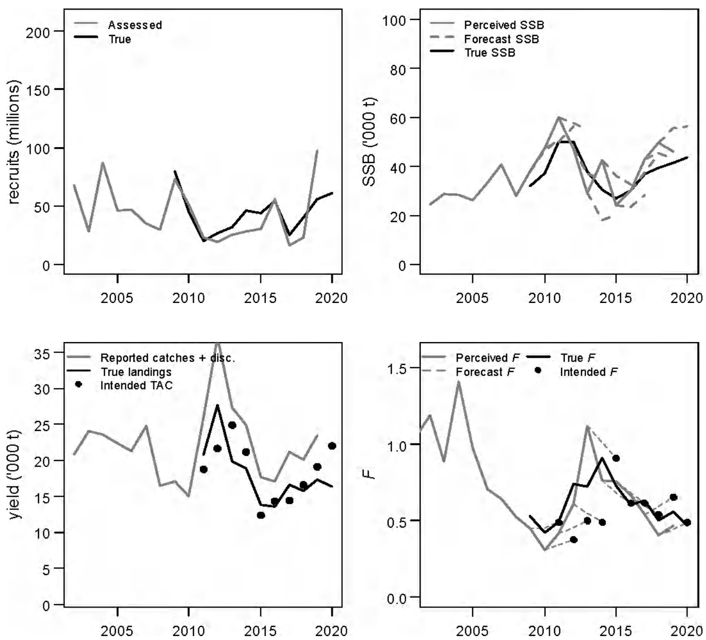

Figure 11.1.1 One selected run for the baseline projection of the LTMP (i.e. F reduction with TAC and effort regime) simulated with the fleet-based model.

This plot shows that the actual population is impacted by the implemented tac and effort regime with some delays while the short-term targets applying the LTMP regularly changes of direction (i.e. increase/decrease the TAC and the effort) also with some delays creating oscillation in individual trajectories.

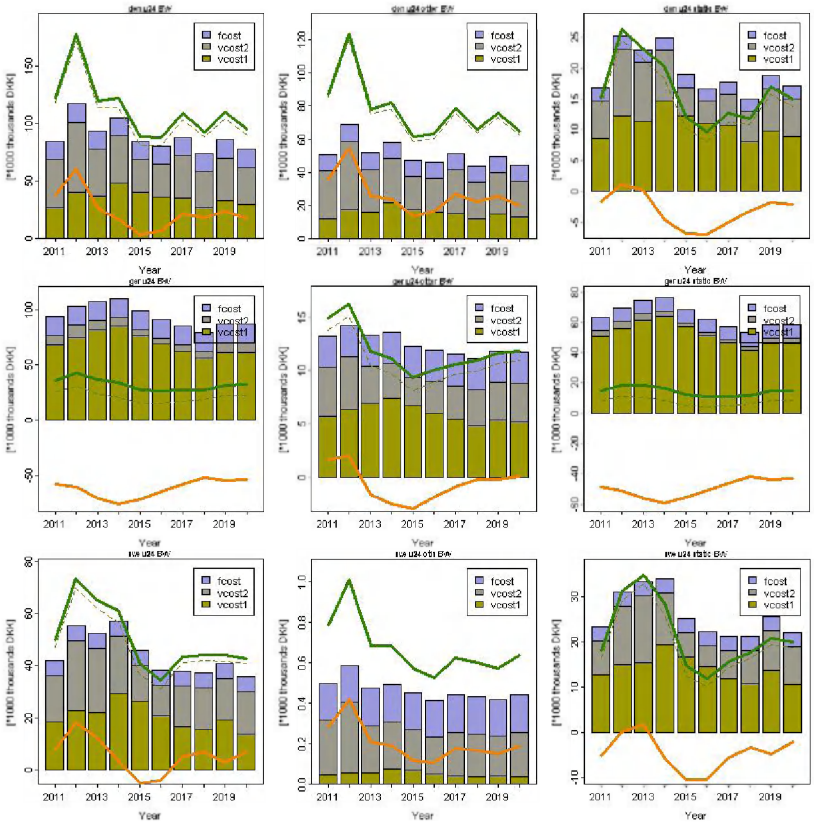

Figure 11.1.2 One selected run (the same as previous figure) for the fleet-specific bioeconomic baseline projection of indicators in DKK (green solid line: gross return, orange solid line: profit) for selected fleet-segments under the LTMP (i.e. F reduction with TAC and effort regime) simulated with the fleet-based model.

Negative profits for some segments…Should be in euro and updated with the most recent economic data for costs and prices

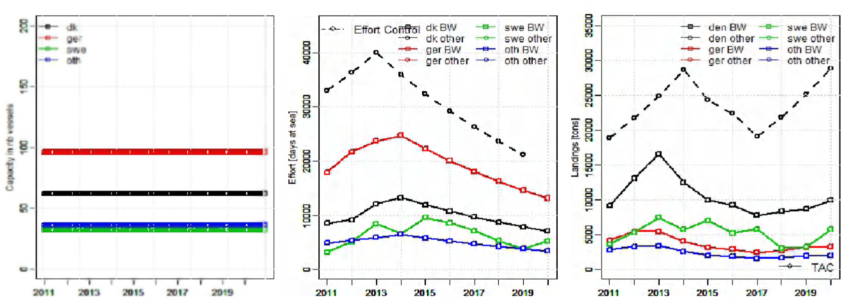

Figure 11.1.3 Capacity (left, i.e. given the effort in 2009 and assuming 20 days at sea for a mean vessel), total effort and effort per fleet-segment (center), cod tac and landings per fleet-segments (right) for one selected run (the same as previous figure) simulated with the fleet-based model.

This plot indicates that for this given run, the effort is initially increasing as the assessed F is below the Ftarget of 0.6 and then is regularly decreasing while the F is still above the target. The effort reduction is implemented in terms of days at sea per vessel while the capacity is assumed to remain constant within the simulation. Note that the TACs are sometimes not completely taken for various reasons (given the effort some fleets segments are no longer able to catch their quotas, or the actual population does not permit the intended amount of fish to be taken, or the implementation error led to lower or higher TACs than the ones advised by the stock assessment, etc.)

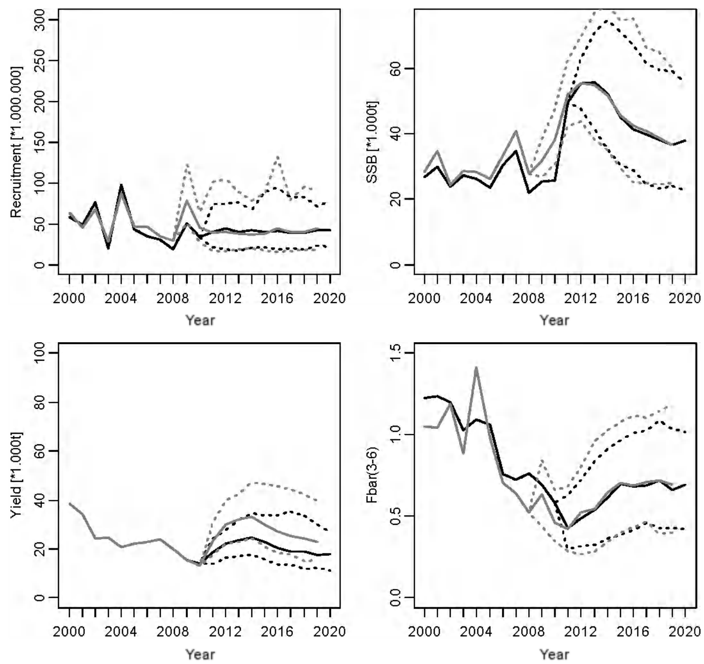

Figure 11.1.4OM vs. MP for the baseline with the fleet-based model (N=100).

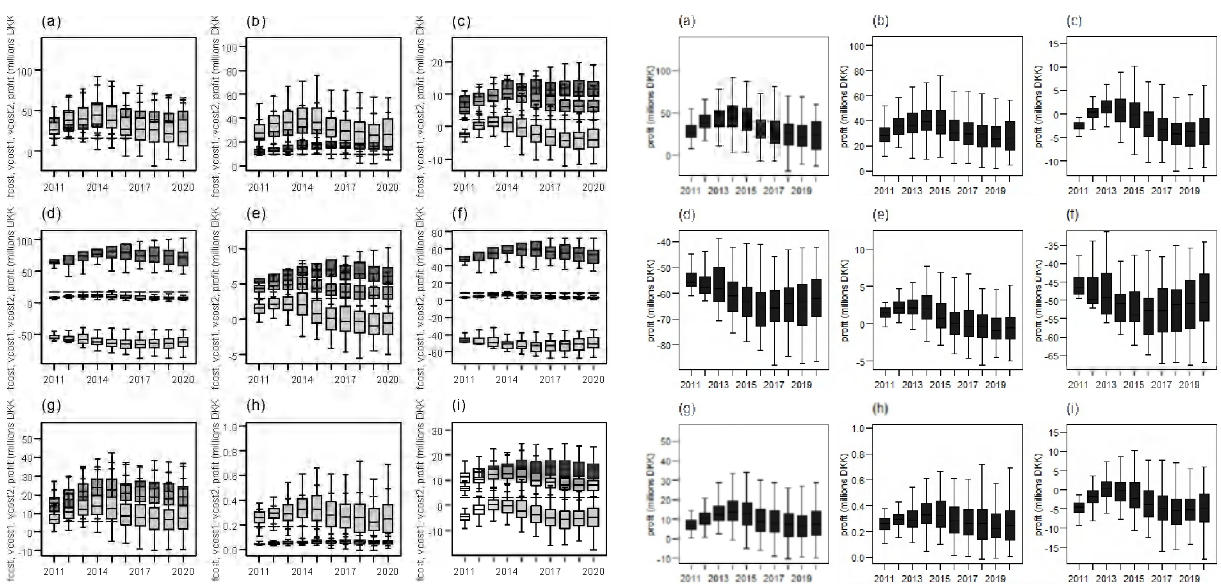

Figure 11.1.5Left- Box and Whiskers plots of the economic indicators in DKK per fleet (a. den u24, b. den u24 otter, c.den u24 static, d. ger u24, e. ger u24 otter, f. ger u24 static, g. swe u24, h. swe u24 oth, i.swe u24 static) for the baseline with the fleet-based model (N=100) with, from dark to light grey respectively, the fixed costs, the variable cost depending on effort, the variable cost depending on gross revenue from landings and the net profit. Right- same as the left panel but only profit is displayed.

11.2. **Impact evaluation**

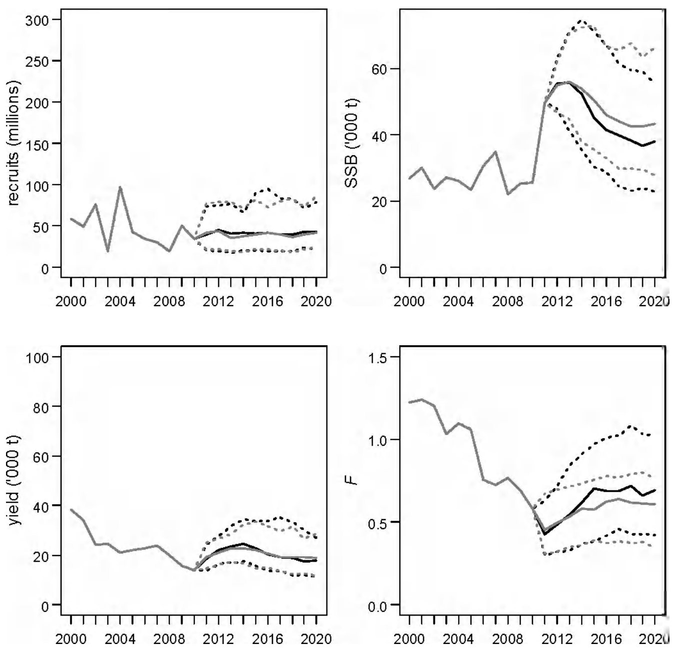

Figure 11.2.1 Impact evaluation of the LTMP without the effort control simulated with the fleet-based model (baseline LTMP (black) vs. TAC only (grey))

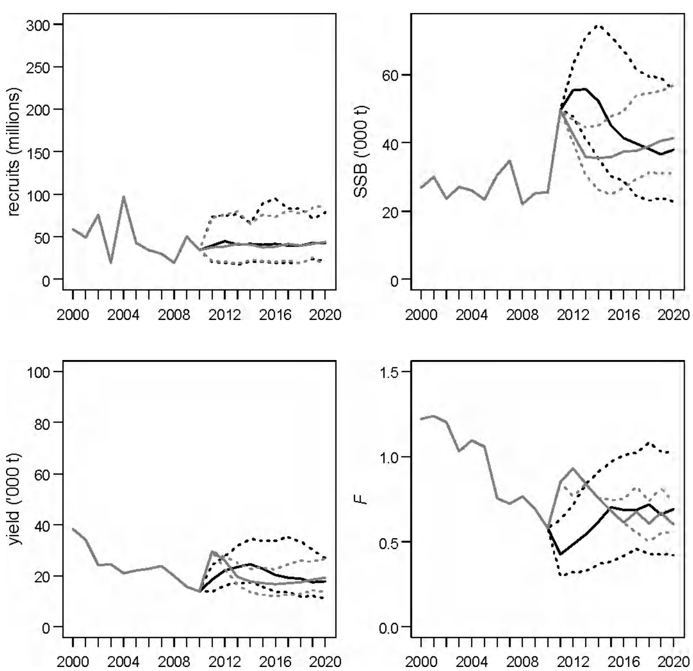

Figure 11.2.2 Impact evaluation of the LTMP without the TAC simulated with the fleet-based model (baseline LTMP (black) vs. Effort only (grey))

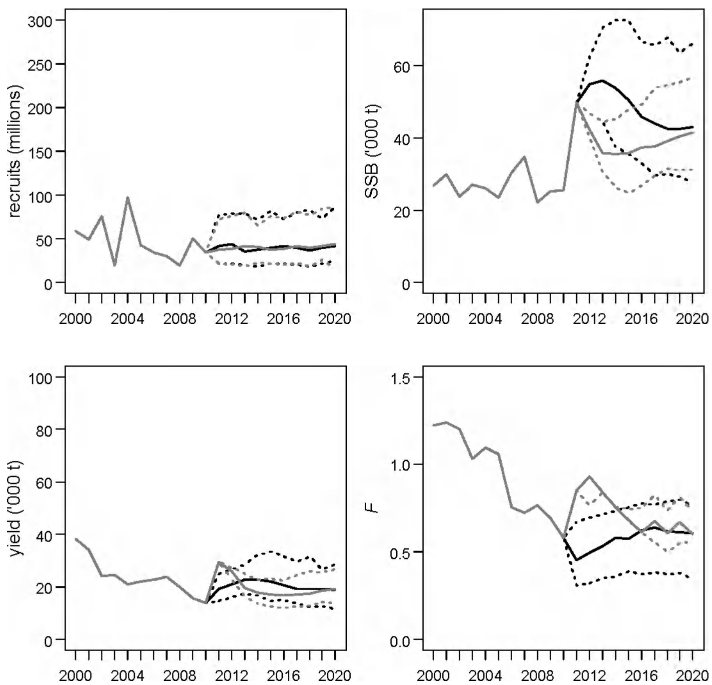

Figure 11.2.3 Impact evaluation with the fleet-based model of the LTMP including the TAC only (black) or including the effort control only (grey)

The results indicate that the respective contribution of the TAC and the effort control (in agreement with the F adaptive management, i.e. reduction until reaching the F target, increase after) to the LTMP is different in the sense that the effort control alone led to higher F and smaller SSB because of higher catches in the short term when the TAC was no longer constraining the catches. Additionally, for the first projected years the effort control could have led to increase in the total effort driven by the HCR when the assessed F was close to the 0.6 target (but just below). All in all, the LTMP (i.e. TAC + effort control) appeared slightly less efficient compared to a TAC regime alone (because by no way the simulations allow an increase of effort beyond the historic one while the effort regime alone do) but this small discrepancy is likely to be due to the fact that the F is already close to the target of 0.6.

One should bear in mind that previous studies (e.g. Bastardie *et al.*, 2010b) showed that the added value of the effort control (added to the TAC regime) was to make the multi-annual plan more robust by limiting potential unexpected increase in nominal effort or catching power and prevent over-quota consequences on the stock evolution and the stock assessment procedure.

As no description in the core text of the regulation was available so far to document the concrete implementation of the 10% effort reduction requested by the plan, this aspect was applied as a 10% reduction of the effort to each individual vessel. Notice that an alternative way of simulating the effort plan would have been to set a more and more restrictive effort ceiling per area for each vessel whatever its own historic effort records was based on a 10 % reduction a year applied on a 'mean vessel', i.e. the vessel averaging the yearly effort per vessel of the whole fleet. This last case would actually sometimes permit increase of individual effort instead of decreased one, e.g. when the historic effort records for a given vessel were lower than the ones of the mean vessel.

This evaluation also includes bio-economic evaluation and cost effectiveness of effort and TAC regulation.

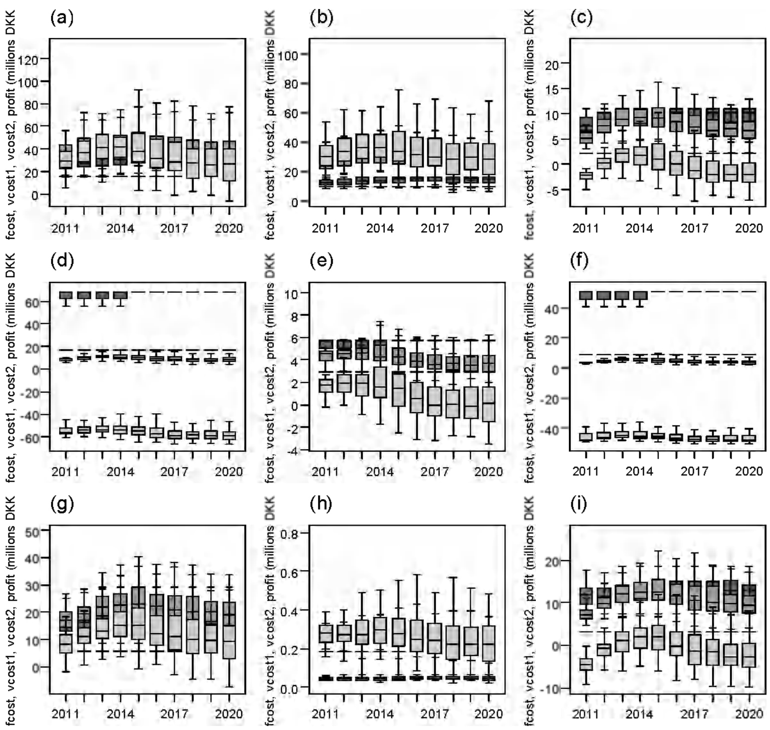

Figure 11.2.4 Box and Whiskers plots of the economic indicators in DKK per fleet-segments with the fleet-based model for LTMP without the effort control

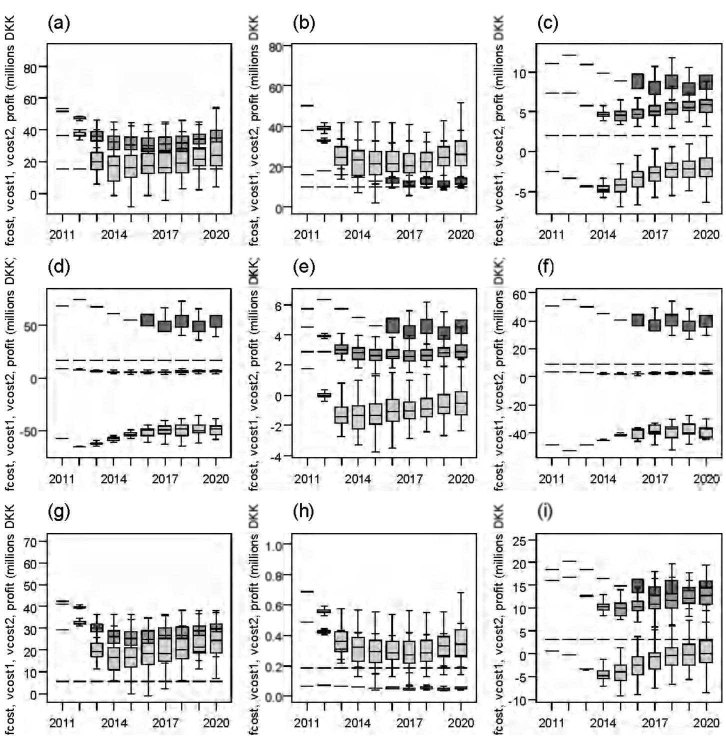

Figure 11.2.5 Box and Whiskers plots of the economic indicators in DKK per fleet-segments with the fleet-based model for LTMP without the TAC regime

25.0 Results based management - effectiveness of the LTMP in relation to catch quota and no discard

Evaluation of scenarios including results-based management (such as the Danish Catch Quota Management System described in e.g. Kindt-Larsen *et al.*, 2011) is performed with the fleet-based version of the FLR model, for which we are awaiting final economic data to present. The results of the fleet based simulations comparing a catch quota system for the Western Baltic cod with no discards and with a corresponding increase of the TAC of 10% are presented here.

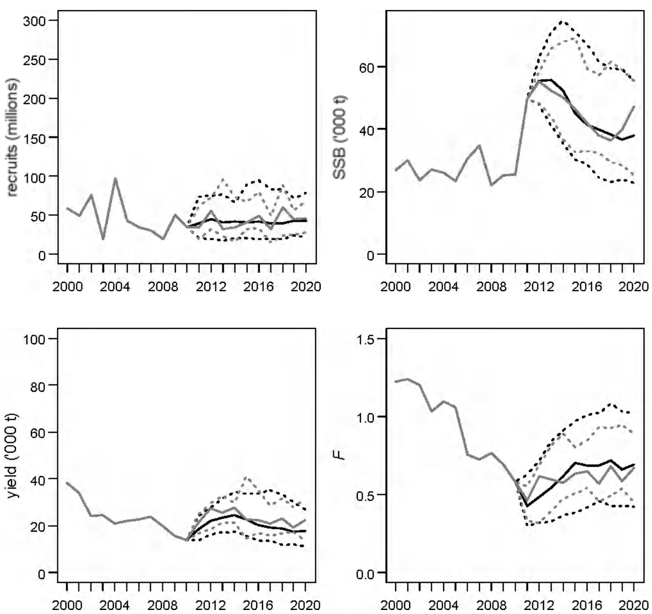

Figure 12.1 Impact evaluation of the LTMP with no allowed discards and an increased TAC by 10% (suggested to compensate fishermen) simulated with the fleet-based model (baseline LTMP (black) vs. TAC +10% (grey))

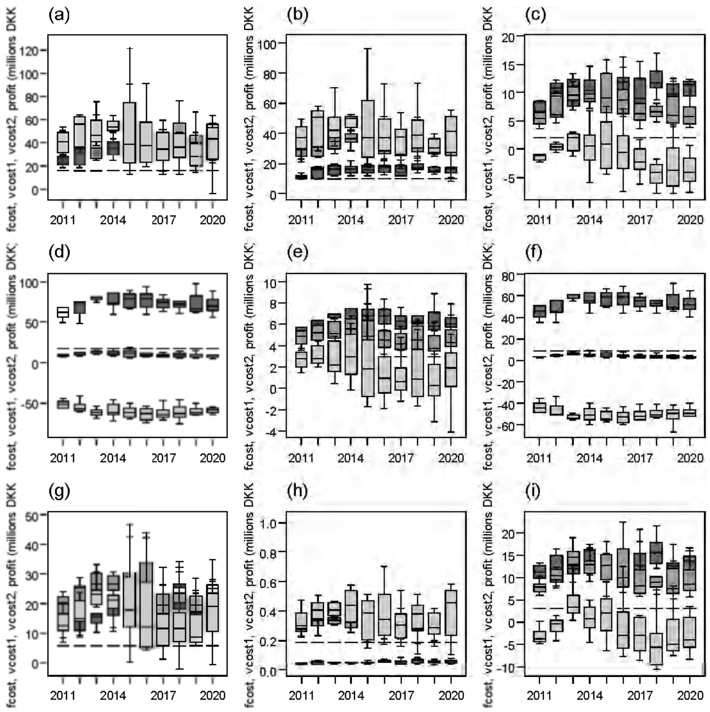

Figure 12.2 Box and Whiskers plots of the economic indicators in DKK per fleet-segments with the fleet-based model for LTMP with no allowed discards + 10% TAC compensation

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Annex 4 Size matters: short term loss and long term gain in a size-selective fishery

By Joakim Hjelm and Massimiliano Cardinale*

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Introduction

Nowadays it is well established that successful management of fish resources requires the involvement of a broad range of stakeholders including fishermen, conservation groups, scientists and different governmental and non-governmental agencies (IOC-UNEP 2009). Participation in decision making is the core of the ecosystem based approach to fisheries (EAF) and the need to apply an ecosystem approach to fisheries management (EAFM) is now globally accepted (Jennings and Rice 2011). The purpose of an ecosystem based approach to fisheries management (EAFM) is to restore and maintain well functioning ecosystems that are able to supply various kinds of ecosystem services to humans, including sustainable fishing, biodiversity and functioning food webs (FAO 2003). Moreover, EAFM is aiming to achieve sustainable development and contribute to food security and human development by maintaining environmental integrity and enhancing social well-being and by reducing intra- and inter-sectoral conflict through participatory approaches and stakeholder consultation (EC 2008). Application of EAFM implies a balanced approach to address ecosystem good status and thus it would contribute positively to biodiversity, governance and human well-being, including social development and poverty alleviation (FAO 2003). Thus EAFM is also very useful in situations where conflict resolution is required. It is apparent that fishermen, conservation groups, scientists and different governmental and non-governmental agencies have different objectives, and place different values on the marine environment which makes common solutions usually hard to achieve. These conflicts have been one of the reasons for the past failure in managing sea resources, at least in Europe (EC 2009).

Recently, maximum sustainable yield framework (MSY) as been adopted within the EAFM framework where the objective is to achieve the highest possible yield over the long term (i.e. an infinitely long period of time) from a given stock (EC 2006). Ideally, a fishing mortality MSY reference level (i.e. F_{MSY}) should take into account recruitment, growth and natural mortality under current or recent ecosystem conditions. Thus F_{MSY} is used as a generic term for a robust estimate of a fishing mortality level that is associated with high yield in the long term with the current harvesting regime in terms of size selectivity. Here we used Eastern Baltic cod stock (ICES SD 25-32; ICES 2010) as an example to demonstrate that an alternative harvesting regime in terms of size selectivity applied on this cod stock could increase the economic revenue for the industry, and at the same time increases ecosystem integrity and improve its resilience to climate changes and exploitation. Here we advocate that economic reasoning may offer an important tool for the management of marine resources by potentially providing a common currency for the different stakeholders that may be able to offer guidance to solve conflicts and achieve long term sustainability and human well-being.

Materials and methods

Here we aimed to assess the effect of different harvesting scenarios on the Eastern Baltic cod stock in terms of economic revenue for the fleet. We used a set of deterministic medium term projections from

2010 to 2025 to simulate the effect of a possible change in the fleets' selectivity (i.e. gear mesh size) in order to eliminate catches of cod smaller than the optimal length. Optimal length (L_{opt}) was defined as the mean length of the age group in which the biomass of an unexploited cohort reaches its maximum growth potential (Froese et al. 2008). For Eastern Baltic cod L_{opt} is around 70-77 cm of total length and 5 years of age. For this simulation, we assumed the same natural mortality at age, growth parameters and length-weight parameters of a cohort exploited at the current fishing mortality (F_{cur}). The model parameters and the starting population numbers used here were the same as those estimated by ICES (International Council of the Exploration of the Sea) in the assessment of the Eastern Baltic cod in 2010 (i.e. number at age, weight at age, maturity at age and natural mortality at age) (ICES 2010). The stock-recruitment relationship was modeled using a geometric mean recruitment estimated over the last five years (2005-2009).

Different scenarios were simulated including: (i) F_{cur} = 0.23 (i.e. the current fishing mortality estimated in 2009 by ICES) and (ii) F_{mp} = 0.30 (i.e. the target fishing mortality according to the current management plan) with the current harvest selectivity. These two scenarios were compared against other two scenarios with a different harvest selectivity, which takes into consideration the growth potential of the Eastern Baltic cod; Those were defined as (iii) F_{opt1} = 0.30 estimated as an average fishing mortality for fish of 5 years of age and older, and iv) F_{opt2} = 0.30 estimated as an average fishing mortality for fish 6 years of age and older. In other words, in the F_{opt1} and F_{opt2} scenario assume that fish are caught only after they have reached 5 or 6 years of age and being 70-77 cm or larger. Simulations were run assuming two different market price scenarios; an equal market price for all size classes of cod and a second scenario where the cod price was size-dependent, i.e. largest cod fetches 65% more per kg than the smaller size categories (based on Swedish cod prices in 2010).

Results and Discussion

The results of the simulations suggest that by using different harvest selectivity and thus changing the size range of harvested cod, we can largely increase the revenue of the Eastern Baltic cod fishery compared to both F_{curr} and F_{MP} while assuring sustainable high long term yield (Figure 1). The reason is that both F_{curr} and F_{MP} are based on the current fishing selectivity of the fleet while we would be able to harvest a much larger biomass of cod if the average size at harvesting would have been close to its maximum growth potential (i.e. L_{opt} which for Eastern Baltic cod is around 70-77 cm of total length). Managing the stock according to the proposed strategy would provide a larger harvest than with the present management system and, at the same time, the stock would consist of a greater proportion of large and older individuals (i.e. resemble a more unexploited status). It is important to note that, even if fishing is aimed solely at the largest individuals, there will still be considerably more large cod remaining in the population after fishing compared to the current situation, provided that the fishing mortality is kept on the agreed reference level (i.e. F_{MP} = 0.30). This framework presented here is rather similar to what is called the L_{opt}-harvesting strategy (Beverton and Holt 1957; Froese et al. 2008), i.e. the fish is caught only after a cohort has reached its maximum growth in biomass, corresponding to the so-called optimal length (L_{opt}). Moreover, the L_{opt} strategy implies that cod has matured and thus spawned several times compared to the current management strategy, which allows fish to spawn in average only once (Reference?). Also, assuming a higher price per kilo for larger cod (in 2010 the price of the different commercial size categories of cod differ of 65% in the Swedish market; size-dependent price scenario), the increase in long term revenues with a L_{opt} strategy is even much larger than compared to any other scenario analysed here.

Thus, simulations here showed that in order to obtain an increase in the economic revenue of the fishery, harvesting needs to be restricted to those lengths close or larger than the estimated L_{opt} of Eastern Baltic cod. This can be achieved using a different gear selective than currently applied. Size selection is largely used in fisheries, thus knowledge and methods for developing size selective gear is already well established (e.g. larger mesh size in the trawl cod-end and the use of more size selective gear as long line, pots and gillnets, etc (e.g. Madsen and Valentinsson 2010)). In other words, the key difference in the L_{opt} management scenarios is that the predicted size at landings is much larger than the current minimum landing sizes of Eastern Baltic cod.

As shown in Figure 1, an initial increase in size selective harvesting (i.e. L_{opt} management strategies) will result in an initial loss in economic revenue. This is due to the fact that currently few large cod are present in the population (ICES 2010). However, based on size-dependent price scenario, only after approximately four years, the cumulative economic revenue will be similar to the management plan regime scenario, and after five years the cumulative revenue of the L_{opt} management strategies will be higher than any other management scenario (Figure 1). On the other hand, assuming equal price for all size classes of cod, it will take about 7 years for cumulative economic revenues under a L_{opt} management strategy to be higher than the management plan regime scenario. Assuming a size dependent price, the total loss in the first 3 years will be in average 50 millions € annually according to the F_{opt1} scenario (harvesting cod 5 years and older) and approximately 75 millions € annually according to the F_{opt2} scenario (harvesting cod 6 years and older). Instead, assuming an equal price for all size classes of cod, the losses will be 64 and 93 millions € annually for F_{opt1} and F_{opt2}, respectively. It would take between 4 years (variable price) and 7 years (fixed price) to compensate the initial loss for implementing a L_{opt} management strategy under the assumption that no compensation for loss of revenue is paid to the fishermen. The shorter time for size-dependent price scenario is due to the fact that the loss in landings is compensated by the higher price of larger commercial size categories of cod. After 3 years, in the size-dependent price scenario, F_{opt1} gives higher revenue of about 60 millions € annually and F_{opt2} of 95 millions €. On the other hand, assuming equal price for all size categories of cod, F_{opt1} gives higher revenue of about 30 millions € annually and F_{opt2} of 50 million €.

It is well known that size-selective mortality can, in theory, affect many life history characteristics of fish (Sharpe and Hendry 2009) as for example select for slow growth and early maturation in an exploited population (Jennings and Revill 2007). Current fishing selectivity has been shown repeatedly to alter population size structure, growth rates, and the timing of maturation (Law 2007) as well as provoking changes at all levels of the marine ecosystem via trophic cascades (Frank et al. 2005; Casini et al. 2008). The reduction of large fishes, which are usually located at the higher levels of the trophic chain, alter the dynamics of the lower trophic levels and the entire ecosystems is transformed (Daskalov et al. 2007, Casini et al. 2009). Such fishing-induced trophic modifications will result in changes in the composition and abundance of species, often exacerbated by large-scale oceanographic change (Frank et al. 2005, 2006; Casini et al. 2009). Populations with a reduced abundance of large fish have been demonstrated to suffer an increased variability in recruitment, unstable population dynamics and reduced ability to contrast environmental fluctuations (Anderson et al. 2008). In that context, a size-selective harvesting regime will also have beneficial effects on the stock dynamics and ecosystem. A L_{opt}-strategy, which means that the fish is caught only after it has reached optimal length and thus has spawned several times, can counteract many of these negative effects, including genetic selection (Hutchings 2009) allowing the population to be more similar in size structure to an unexploited situation, where the biomass and average size of the stock is much larger than observed today. Here we have shown as implementing the MSY concept in terms of fishing mortality but neglecting size selectivity will not achieve high long term yield for Eastern Baltic cod. Instead, the application of a size selective harvesting can be considered as a further step in the implementation of EAFM that will likely bring us much closer to the realisation of the MSY strategy in fisheries management. Nevertheless, it is also important to notice that Eastern Baltic cod fisheries constitute the ideal situation for the success of a size selective harvesting. More challenging would be the strict application of a size selective harvesting in a mixed fisheries context where the use of highly selective gears for maximising long term yield of the predator species will likely lead to a large reduction of catches of other species. In this situation, we believe that the developing of highly species selective gears would constitute the way forward.

We also argue that size does matter in fisheries management. Most of the stakeholders involved in fisheries indeed desire big fish. The fleet wish large catches, conservation groups wants to protect the big fish in the ocean, scientists and different governmental and non-governmental agencies strain to achieve sustainability and good ecosystem status that is often associated with the presence of a large proportion of large fish in the ecosystem, divers and sport fisherman are continuously out searching for the big ones to catch or to photograph. We believe that size selective harvesting can achieve most of those objectives and it would represent the natural step forward after the implementation of EAFM and MSY concepts.

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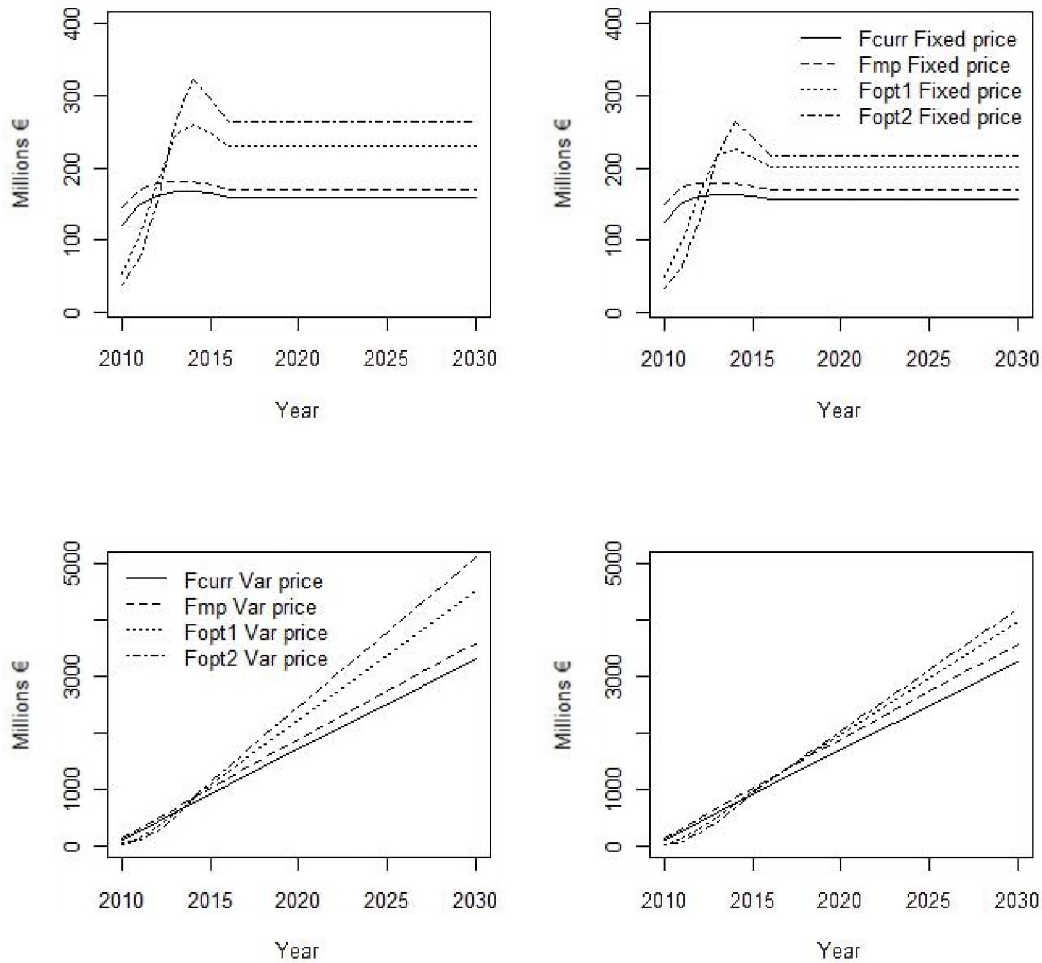

Figure 1. Estimated **a**) Annual economic yield in millions of EUR based on a size-dependent price for the different harvesting scenarios **b**) Annual economic yield in millions of EUR based on an equal price for all size classes of cod for the different harvesting scenarios. The overshoot effect around 2014 (figure a and b) is given by the strong year classes observed in recent years (2005-2009). **c**) Cumulative economic yield in millions of EUR based on a size-dependent price for the different harvesting scenarios and **d**) Cumulative annual economic yield in millions of EUR based on an equal price for all size classes of cod for the different harvesting scenarios. F_{curr} = current fishing mortality; F_{MP} = target fishing mortality for the management plan; F_{opt1} = Fishing mortality on 5 years and older individuals and F_{opt2} = Fishing mortality on 6 years and older individuals.

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Abstract

A joint ICES / STECF meeting was held in Hamburg 20-24 June 2011, to prepare Impact Assessments for Southern hake, Nerphrops and Angler fish and Baltic cod and an Evaluations of existing plans for Kattegat, North Sea, West of Scotland and Irish Sea cod. The meeting involved STECF, ICES scientists dealing with Economy and Biology and included Observers (Commission staff, Managers, Stakeholders). Three separate reports to the STECF were prepared by the EWG-11-07, one on the Impact Assessment of Southern hake, Nerphrops and Angler fish (STECF 11-06) and another on the Impact Assessments for Baltic cod (STECF 11-05) and the third on the Evaluation of Cod in Kattegat, North Sea, West of Scotland and Irish Sea (STECF 11-07). All reports were reviewed by the STECF during its 37th plenary meeting held from 11 to 15 July 2011 in Copenhagen, Denmark. The observations, conclusions and recommendations, in this report represent the outcomes of the Impact Assessment of Multi-Annual plans for cod in the Baltic.

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The Scientific, Technical and Economic Committee for Fisheries (STECF) has been established by the European Commission. The STECF is being consulted at regular intervals on matters pertaining to the conservation and management of living aquatic resources, including biological, economic, environmental, social and technical considerations.

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