Characterising and predicting the distribution of Baltic Sea flounder during the spawning season

Identification of essential fish habitats (EFH), such as spawning habitats, is important for nature conservation, sustainable fisheries management and marine spatial planning. Two sympatric flounder (Platichthys flesus) ecotypes are present in the Baltic Sea, pelagic and demersal spawning flounder, both displaying ecological and physiological adaptations to the low-salinity environment of this young inland sea. In this study we have addressed three main research questions: 1) What environmental conditions characterize the spatial distribution and abundance of adult flounder during the spawning season? 2) What are the main factors defining the habitats of the two flounder ecotypes during the spawning season? 3) Where are the potential spawning areas of flounder? We modelled catch per unit of effort (CPUE) of flounder from gillnet surveys conducted over the southern and central Baltic Sea in the spring of 2014 and 2015 using generalized additive models. A general model included all the stations fished during the survey while two other models, one for the demersal and one for the pelagic spawning flounder, included only the stations where each flounder ecotype should dominate. The general model captured distinct ecotype-specific signals as it identified dual salinity and water depth responses. The model for the demersal spawning flounder revealed a negative relation with the abundance of round goby (Neogobius melanostomus) and a positive relation with Secchi depth and cod abundance. Vegetation and substrate did not play an important role in the choice of habitat for the demersal ecotype. The model for the pelagic spawning flounder showed a negative relation with temperature and bottom current and a positive relation with salinity. Spatial predictions of potential spawning areas of flounder showed a decrease in habitat availability for the pelagic spawning flounder over the last 20 years in the central part of the Baltic Sea, which may explain part of the observed changes in populations' biomass. We conclude that spatiotemporal modelling of habitat availability can improve our understanding of fish stock dynamics and may provide necessary biological knowledge for the development of marine spatial plans.
Eastern Baltic cod recruitment revisited—dynamics and impacting factors
The Eastern Baltic cod abundance started rapidly to increase in the mid-2000s as evidenced by analytical stock assessments, due to increased recruitment and declining fishing mortality. Since 2014, the analytical stock assessment is not available, leaving the present stock status unclear and casting doubts about the magnitude of the recent increase in recruitment. Earlier studies identified main factors impacting on cod reproductive success to be related to the loss of two out of three spawning areas in the 1980s caused by lack of major Baltic inflows with a concurrent reduction in salinity and oxygen. Other important factors include prey availability for first-feeding larvae, egg predation by sprat and herring and cannibalism on juveniles, all in one way or the other related to the prevailing hydrographic conditions. These factors cannot explain increased reproductive success in the last decade, as the period was characterized by an absence of large-scale Baltic inflows since 2003 and persistent anoxic conditions in the bottom water of the deep Baltic basins. This questions the perception of the increased recruitment in later years and challenges our present understanding of cod recruitment dynamics in the Baltic Sea. In this contribution, we review evidence from the recent literature supplemented by information from latest research cruises to elucidate whether cod reproductive success indeed has increased during the last decade, and we suggest the key processes responsible for the recent dynamics in cod recruitment and outline directions for future research.

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Organisations: National Institute of Aquatic Resources, Institute Management, Section for Marine Ecology and Oceanography, Section for Ecosystem based Marine Management, GEOMAR - Helmholtz Centre for Ocean Research Kiel, Fishery Resources Research Department, National Marine Fisheries Research Institute, Institute for Hydrobiology and Fisheries Science, Thünen Institute of Baltic Sea Fisheries
Authors: Köster, F. (Intern), Huwer, B. (Intern), Hinrichsen, H. (Ekstern), Neumann, V. (Intern), Makarchouk, A. (Ekstern), Eero, M. (Intern), Dewitz, B. V. (Ekstern), Hüsey, K. (Intern), Tomkiewicz, J. (Intern), Margonski, P. (Ekstern), Temming, A. (Ekstern), Hermann, J. (Ekstern), Oesterwind, D. (Ekstern), Dierking, J. (Ekstern), Kotterba, P. (Ekstern), Plikshs, M. (Ekstern)
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Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 2.18
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Scopus rating (2014): CiteScore 2.62
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Faster or slower: Has growth of juvenile eastern Baltic cod changed?

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Organisations: National Institute of Aquatic Resources, Section for Oceans and Arctic, Section for Ecosystem based Marine Management
Authors: Hüssy, K. (Intern), Radtke, K. (Ekstern), Eero, M. (Intern)
Publication date: 2017
Main Research Area: Technical/natural sciences
Publication: Research › Conference abstract for conference – Annual report year: 2017

How old are you—Evaluation of age reading methods for the invasive round goby (Neogobius melanostomus, Pallas 1814)
In the Baltic, the first observation of the round goby (Neogobius melanostomus, Pallas 1814) was made in 1990. Within the past decade the species became invasive and spread rapidly throughout the Baltic Sea. Studies about the fishes potential impacts on resident species promote the need for an increasing knowledge of their basic stock structures such as growth rates, longevity and mortality, which all rely on accurate estimates of age. Former studies on the round goby have used several different age reading techniques. In this study, we compared three standard otolith preparation methods for ageing and present the best procedure for the invasive round goby. The results showed significant differences in age estimates of the same fish between the different preparation methods and between readers. The estimation of the first annulus, the first year, was the most problematic. The overall agreement was lowest when reading the whole otoliths while the best performance was achieved with sectioned and stained preparation method. Depending on method used the growth estimates also differed. The results question comparability between previous studies and highlight the importance of harmonised aging procedures for the round goby for obtaining correct estimates of population
parameters such as growth rate, age at maturity, and longevity

General information
State: Accepted/In press
Organisations: National Institute of Aquatic Resources, Section for Oceans and Arctic, Swedish University of Agricultural Sciences, Thünen Institute of Baltic Sea Fisheries, Institute of Food Safety Animal Health and Environment BIOR, Swedish University of Agricultural Sciences, University of Gdansk, Finnish Environment Institute
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Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.94
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 0.84
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 1.06
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 0.99
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 0.99
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 1.04
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Web of Science (2010): Indexed yes
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Web of Science (2001): Indexed yes
Web of Science (2000): Indexed yes
Original language: English
DOIs: 10.1111/jai.13596
Publication: Research - peer-review › Journal article – Annual report year: 2017

Spatio-temporal dynamics of cod nursery areas in the Baltic Sea
In this study the drift of eastern Baltic cod larvae and juveniles spawned within the historical eastern Baltic cod spawning grounds was investigated by detailed drift model simulations for the years 1971–2010, to examine the spatio-temporal dynamics of environmental suitability in the nursery areas of juvenile cod settlement. The results of the long-term model scenario runs, where juvenile cod were treated as simulated passively drifting particles, enabled us to find strong indications for long-term variations of settlement and potentially the reproduction success of the historically important
eastern Baltic cod nursery grounds. Only low proportions of juveniles hatched in the Arkona Basin and in the Gotland Basin were able to settle in their respective spawning ground. Ocean currents were either unfavorable for the juveniles to reach suitable habitats or transported the juveniles to nursery grounds of neighboring subdivisions. Juveniles which hatched in the Bornholm Basin were most widely dispersed and showed the highest settlement probability, while the second highest settlement probability and horizontal dispersal was observed for juveniles originating from the Gdansk Deep. In a long-term perspective, wind-driven transport of larvae/juveniles positively affected the settlement success predominately in the Bornholm Basin and in the Bay of Gdansk. The Bornholm Basin has the potential to contribute on average 54% and the Bay of Gdansk 11% to the production of juveniles in the Baltic Sea. Furthermore, transport of juveniles surviving to the age of settlement with origin in the Bornholm Basin contributed on average 13 and 11% to the total settlement in the Arkona Basin and in the Gdansk Deep, respectively. The time-series of the simulated occupied juvenile cod habitat in the Bornholm Basin and in the Gdansk Deep showed a similar declining trend as the Fulton's K condition factor of demersal 1-group cod, which may confirm the importance of oxygen-dependent habitat availability and its effect on density dependence as a process relevant for recruitment success.
Using genetics to identify management units of European flounder in the Baltic Sea

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Oceans and Arctic, Swedish University of Agricultural Sciences
Authors: Florin, A. (Ekstern), Palm, S. (Ekstern), Ustups, D. (Ekstern), Hüssy, K. (Intern), Casini, M. (Ekstern), Nissling, A. (Ekstern), Limburg, K. (Ekstern), Schade, F. (Ekstern)
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1.500 mærkede torsk skal give bedre bestandsvurdering

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography, Section for Monitoring and Data, Danish Fishermen's Producers' Organization
Authors: Hüssy, K. (Intern), Olesen, H. J. (Intern), Hansen, K. K. (Ekstern), Lund, H. S. (Ekstern)
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Baltic cod recruitment – the impact of changing environmental conditions

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Organisations: National Institute of Aquatic Resources, Institute Management, Section for Marine Ecology and Oceanography, Section for Ecosystem based Marine Management, Leibniz Institute of Marine Sciences
Authors: Köster, F. (Intern), Huwer, B. (Intern), Hinrichsen, H. (Ekstern), Neumann, V. (Intern), Makarchouk, A. (Ekstern), Eero, M. (Intern), von Dewitz, B. (Ekstern), Tomkiewicz, J. (Intern), Hüussy, K. (Intern), Plikshs, M. (Ekstern)
Publication date: 2016
Main Research Area: Technical/natural sciences

Challenging ICES age estimation protocols: lessons learned from the eastern Baltic cod stock

Over the recent decades, the International Council for the Exploration of the Sea (ICES) has set guidelines for best practise quality control of age estimation procedures. The applicability of these guidelines is assessed by reviewing the ageing issues of eastern Baltic cod (EBC) as a case study. Since the implementation of an age-based assessment of EBC in the beginning of the 1970s, the assessment has been hampered by the quality of the age composition data, in recent years to a degree that age-based assessment is no longer used. The reason for the age reading problems is the low visual contrast between growth zones in the otoliths which seems to be the result of complex interactions of the hydrography in the Baltic Sea with the cod’s biology and behaviour. Over the last 40 years, various expert groups have struggled to document and improve the agreement of age estimation between national otolith readers, standardize methods and age estimations through repeated exchanges and reference collections as well as an internationally agreed manual. Despite these initiatives the precision of the age estimations based on traditional ageing did not improve, with significant bias persisting between and within readers. Additionally, a wide range of alternative methods for deriving the age information necessary for stock assessment and for validation of the true age have been tested. However, these methods did not produce unbiased age estimates over the entire size and age range of the EBC stock. An age-validation is urgently needed. Deviations from the ICES guidelines identified are as follows: (i) the lack of rigorous quality control, particularly the auditing of national trends in age precision over the years using a reference collection and (ii) the implementation of an age error matrix in the stock assessment.

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Organisations: National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography, National Marine Fisheries Research Institute, Institute of Food Safety, Animal Health and Environment, Thünen Institute of Baltic Sea Fisheries, Swedish University of Agricultural Sciences
Authors: Hüussy, K. (Intern), Radtke, K. (Ekstern), Plikshs, M. (Ekstern), Oeberst, R. (Ekstern), Baranova, T. (Ekstern), Krumme, U. (Ekstern), Sjöberg, R. (Ekstern), Walther, Y. (Ekstern), Mosegaard, H. (Intern)
Pages: 2138-2149
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Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 2.18
Web of Science (2015): Indexed yes
Connectivity of larval cod in the transition area between North Sea and Baltic Sea and potential implications for fisheries management

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

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography, Section for Ecosystem based Marine Management, GEOMAR - Helmholtz Centre for Ocean Research Kiel
Authors: Huwer, B. (Intern), Hinrichsen, H. (Ekstern), Hüssy, K. (Intern), Eero, M. (Intern)
Pages: 1815-1824
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Ecosystem indicators in the context of fisheries management: example of cod in the Baltic Sea

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Organisations: National Institute of Aquatic Resources, Section for Ecosystem based Marine Management, Section for Marine Ecology and Oceanography, Institute Management
Authors: Eero, M. (Intern), Casini, M. (Ekstern), Hüssy, K. (Intern), Köster, F. (Intern), MacKenzie, B. (Intern), Neuenfeldt, S. (Intern), Tomkiewicz, J. (Intern)
Publication date: 2016
Event: Abstract from World Fisheries Congress, Busan, Korea, Republic of.
Main Research Area: Technical/natural sciences
Publication: Research › Conference abstract for conference – Annual report year: 2016

Evaluation of otolith shape as a tool for stock discrimination in marine fishes using Baltic Sea cod as a case study
In the Western Baltic Sea two genetically distinct cod stocks "Eastern Baltic cod" and "Western Baltic cod" occur with considerable mixing of stocks. In this study we evaluated the applicability of otolith shape analysis for classification of individuals caught in the mixed stock cod fishery, using SNP (single nucleotide polymorphism) based genetic assignment of otolith shape baselines. We further developed a management aimed approach for mixed stock assignment by robust stochastic baseline selection and posterior bias correction by individual reassignment of the least likely classifications into the alternate stock. Classification criteria selected by Monte Carlo runs of Linear Discriminant Analysis were captured by otolith area and 20 Elliptic Fourier Descriptors of primarily low frequency harmonics. Classification success was considerably lower when using a baseline of spawning individuals only, compared to the better spatial coverage of a combined baseline also including genotyped individuals from the mixed stock area. Furthermore, the inclusion of genotyped individuals balanced the baseline size composition and to a large extent removed a strong size related bias in classification success. These results demonstrate the interplay of environmental, ontogenetic and genetic influences on otolith shape, which complicates the application of otolith shape for stock discrimination in mixed-stock scenarios. Rigours genetic validation and further studies on the temporal dynamics of shape formation are necessary.

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State: Published
Organisations: National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography, Section for Marine Living Resources, Section for Ecosystem based Marine Management
Authors: Hüssy, K. (Intern), Mosegaard, H. (Intern), Albertsen, C. M. (Intern), Eg Nielsen, E. (Intern), Hansen, J. H. (Intern), Eero, M. (Intern)
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- BFI (2016): BFI-level 1
- Scopus rating (2016): CiteScore 2.21 SJR 1.12 SNIP 1.136
- Web of Science (2016): Indexed yes
- BFI (2015): BFI-level 1
- Scopus rating (2015): SJR 1.067 SNIP 1.133 CiteScore 2.01
- Web of Science (2015): Indexed yes
- BFI (2014): BFI-level 1
- Scopus rating (2014): SJR 1.105 SNIP 1.312 CiteScore 2.17
- Web of Science (2014): Indexed yes
- BFI (2013): BFI-level 1
- Scopus rating (2013): SJR 1.037 SNIP 1.173 CiteScore 1.85
- ISI indexed (2013): ISI indexed yes
Fiskere kan være med til at aldersbestemme torsk

General information
State: Published
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Authors: Hüssy, K. (Intern), Lund, H. S. (Ekstern)
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Slave to the rhythm: Can seasonal signals in otolith microchemistry be used as a tool for age estimation?

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Organisations: National Institute of Aquatic Resources, Section for Oceans and Arctic
Authors: Hüssy, K. (Intern), Heidemann, F. (Ekstern), Hinrichsen, H. (Ekstern), Marohn, L. (Ekstern), Gröger, J. (Ekstern), Limburg, K. E. (Ekstern)
Publication date: 2016
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Publication: Research › Conference abstract for conference – Annual report year: 2017

Slave to the rhythm: seasonal signals in otolith microchemistry reveal age of eastern Baltic cod (Gadus morhua)
Annual growth zones in cod otoliths from the eastern Baltic stock are less discrete than in other cod stocks leading to biased age reading, which recently led to a failure of age-based assessment in the eastern Baltic cod stock. In this study, we explored the applicability of minor and trace element patterns in cod otoliths for age determination. By first identifying elements of interest in a stock without ageing problems, western Baltic cod, we then tested their applicability on another stock without ageing problems, North Sea cod, and finally applied this knowledge to estimate age of eastern Baltic cod. In western Baltic cod, matching patterns with respect to occurrence of minima and maxima in both otolith opacity and element concentrations were found for Cu, Zn, and Rb, and inverse patterns with Mg and Mn. No match was found for Pb, Ba, and Sr. In the test stock, the North Sea cod, the same patterns in Cu, Zn, Rb, Mg, and Mn signals occurred. All eastern Baltic cod with low visual contrast between growth zones exhibited clearly defined synchronous cycles in Cu, Zn, Rb and Pb. Using a combined finite differencing method and structural break models approach, the statistical significance of the local profile minima were identified, based on which their age could be estimated. Despite extensive environmental differences between the three areas examined, the element concentrations of Cu, Zn, and Rb were strongly correlated in all individuals with similar correlations in all three areas, suggesting that the incorporation mechanisms are the same for these elements and independent of environmental concentrations.

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Organisations: National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography, Thünen Institute of Fisheries Ecology, GEOMAR - Helmholtz Centre for Ocean Research Kiel, University of Kiel
Authors: Hüssy, K. (Intern), Gröger, J. (Ekstern), Heidemann, F. (Ekstern), Hinrichsen, H. (Ekstern), Marohn, L. (Ekstern)
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Scopus rating (2016): CiteScore 2.63
Web of Science (2016): Indexed yes
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Spatio-temporal trends in stock mixing of eastern and western Baltic cod in the Arkona Basin and the implications for recruitment

General information
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Organisations: National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography, Section for Ecosystem based Marine Management, Section for Marine Living Resources, GEOMAR - Helmholtz Centre for Ocean Research Kiel
Authors: Hüsey, K. (Intern), Hinrichsen, H. (Ekstern), Eero, M. (Intern), Mosegaard, H. (Intern), Hansen, J. H. (Intern), Lehmann, A. (Ekstern), Lundgaard, L. S. (Intern)
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Scopus rating (2015): CiteScore 2.18
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Scopus rating (2014): CiteScore 2.62
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 2.46
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 2.35
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 2.32
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Web of Science (2008): Indexed yes
Web of Science (2007): Indexed yes
Web of Science (2006): Indexed yes
Web of Science (2005): Indexed yes
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Web of Science (2003): Indexed yes
Web of Science (2002): Indexed yes
Web of Science (2001): Indexed yes
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Spawning areas of eastern Baltic cod revisited: Using hydrodynamic modelling to reveal spawning habitat suitability, egg survival probability, and connectivity patterns

General information
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Organisations: National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography, Uppsala University, Institute of Food Safety, Animal Health and Environment, Swedish University of Agricultural Sciences, GEOMAR -
The influence of feeding behaviour on growth of Atlantic cod (Gadus morhua, Linnaeus, 1758) in the North Sea

The objective of this study was to resolve key mechanisms driving individual growth patterns of Atlantic cod (Gadus morhua). Growth dynamics were analysed by linking growth patterns with stomach content composition and environmental temperature. Samples were collected in August/September of the years 2009, 2010 and 2011 in the north-eastern part of the central North Sea. Prey selection was assessed by identification of individual prey items in the stomach content to species. Ten feeding groups were identified consisting of individuals with one prey type dominating their stomach contents (≥75% by mass), of which six were used for growth analyses: “Sandeel”, “Clupeids”, “Norway pout”, “Flatfishes”, “Crustaceans” and “Brittle stars”. For each group, growth patterns were estimated based on measures of otolith growth increments. The stomach contents showed that cod as a species are opportunistic in their prey selection, but at the same time indicated that the total, broad feeding niche width of the population is dominated by individual diet specialization and that many individuals temporally show a preference for a particular prey type. The contribution of invertebrates and particularly crustaceans decreased with increasing cod size, whereas that of fish and predominantly herring increased. Prey type had a significant effect on growth, while temperature had no effect. Slowest growth was observed in the cod group preying on sandeel, while cod preying on Norway pout showed the fastest growth. No significant difference was observed between groups preying on brittle stars, crustaceans, flatfishes and herring. Growth in the year before capture did however not differ between any of these groups. Across sampling years, growth chronology patterns were similar but not significantly influenced by temperature.

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Organisations: National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography, Section for Marine Living Resources
Authors: Hüsey, K. (Intern), Andersen, N. G. (Intern), Pedersen, E. M. (Intern)
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BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.94
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 0.84
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 1.06
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 0.99
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A multi-disciplinary study was conducted to clarify stock identity and connectivity patterns in the populations of European plaice (Pleuronectes platessa) in the Skagerrak-Kattegat transition area between the Eastern North Sea and the Baltic Sea. Five independent biological studies were carried out in parallel. Genetic markers suggested the existence of different genetic populations in the transition area. Growth backcalculation with otoliths resulted in significant although limited differences in growth rates between North Sea and Skagerrak, indicating weak differentiation or important mixing. Hydrogeographical drift modelling suggested that some North Sea juveniles could settle along the coastline of the Skagerrak and the Kattegat. Tagging data suggested that both juveniles and adult fish from the North Sea perform feeding migrations into Skagerrak in summer/autumn. Finally, survey data suggested that Skagerrak also belongs to the area distribution of North Sea plaice. The outcomes of the individual studies were then combined into an overall synthesis. The existence of some resident components was evidenced, but it was also demonstrated that North Sea plaice migrate for feeding into Skagerrak and might constitute a large share of the catches in this area. The mixing of different populations within a management area has implications for stock assessment and management. Choice must be made to either lump or split the populations, and the feasibility and constraints of both options are discussed. The outcomes of this work have directly influenced the management decisions in 2015.
Connectivity, growth and survival in a spatially structured fish population, which is currently managed as seven separate stock units
Eastern Baltic cod in distress: biological changes and challenges for stock assessment

The eastern Baltic (EB) cod (Gadus morhua) stock was depleted and overexploited for decades until the mid-2000s, when fishing mortality rapidly declined and biomass started to increase, as shown by stock assessments. These positive developments were partly assigned to effective management measures, and the EB cod was considered one of the most successful stock recoveries in recent times. In contrast to this optimistic view, the analytical stock assessment failed in 2014, leaving the present stock status unclear. Deteriorated quality of some basic input data for stock assessment in combination with changes in environmental and ecological conditions has led to an unusual situation for cod in the Baltic Sea, which poses new challenges for stock assessment and management advice. A number of adverse developments such as low nutritional condition and disappearance of larger individuals indicate that the stock is in distress. In this study, we (i) summarize the knowledge of recent changes in cod biology and ecosystem conditions, (ii) describe the subsequent challenges for stock assessment, and (iii) highlight the key questions where answers are urgently needed to understand the present stock status and provide scientifically solid support for cod management in the Baltic Sea.
From genes to ecosystems: spatial heterogeneity and temporal dynamics of the Baltic Sea

**General information**

State: Published  
Organisations: National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography, GEOMAR - Helmholtz Centre for Ocean Research Kiel  
Authors: Hüsey, K. (Intern), Dierking, J. (Ekstern), Laikre, L. (Ekstern)  
Number of pages: 3  
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Event: Paper presented at ICES Annual Science Conference 2015, Copenhagen, Denmark.  
Main Research Area: Technical/natural sciences  
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**Bibliographical note**

ICES Theme session Q  
Publication: Research - peer-review › Journal article – Annual report year: 2015

**Invasion rate and population characteristics of the invasive round goby Neogobius melanostomus: effects of density and invasion history**

Round goby Neogobius melanostomus is currently one of the most wide-ranging invasive fish species in Europe and North America. The present study demonstrates how the distribution of round goby has expanded from 2008 to 2013 at a rate of
about 30 km yr⁻¹ along the Danish coastline in the western Baltic Sea. Further analyses showed that fish from an established high-density round goby population were slow-growing and displayed poorer condition (weight at age and hepatosomatic index) compared to fish sampled from recently invaded locations (i.e. at the forefront of the distribution range). The established population revealed a broad age distribution and a 1:1 gender ratio, while fish from a recently invaded site were primarily of intermediate ages with a male-biased gender ratio. Otolith analyses suggested that the oldest individuals from the recently invaded area experienced superior growth conditions only in the most recent years, suggesting immigration into the area as adults. Our results suggest that intraspecific competition for food may cause continued dispersal of the species and that population demographics likely relate to invasion history.
Kortlidsprognoser for kortlivede industrifisk under MSY – forvaltning af tobis i Nordsøen

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Marine Living Resources, Section for Marine Ecology and Oceanography
Authors: Deurs, M. V. (Intern), Christensen, A. (Intern), Bekkevold, D. (Intern), Lynam, C. (Ekstern), Nielsen, K. E. (Intern), Azour, F. (Intern), Lundgaard, L. S. (Intern), Hüsüy, K. (Intern), Mosegaard, H. (Intern), Worsøe Clausen, L. (Intern)
Publication date: 2015

Publication information
Original language: Danish
Main Research Area: Technical/natural sciences

Bibliographical note
Slutrapport for EFF projekt J.nr. 33010-13-k-0280
Publication: Research › Report – Annual report year: 2015

Managing population mixing; genetics supported stock splitting in Atlantic cod

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Marine Living Resources, Section for Marine Ecology and Oceanography, Section for Ecosystem based Marine Management
Authors: Hansen, J. H. (Intern), Hüsüy, K. (Intern), Huwer, B. (Intern), Mosegaard, H. (Intern), Eero, M. (Intern)
Publication date: 2015
Event:
Main Research Area: Technical/natural sciences

Bibliographical note
ICES C.M. 2015/I:12
Publication: Research › Conference abstract for conference – Annual report year: 2015

MSC certification of plaice fisheries in area IIIa: Basic investigations and development of a management plan

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Marine Living Resources, Section for Ecosystem based Marine Management, Section for Monitoring and Data, Section for Marine Ecology and Oceanography
Authors: Hansen, J. H. (Intern), Ulrich, C. (Intern), Boje, J. (Intern), Christensen, A. (Intern), Degel, H. (Intern), Hüsüy, K. (Intern), Worsøe Clausen, L. (Intern)
Number of pages: 52
Publication date: 2015

Publication information
Place of publication: Charlottenlund
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Original language: English

Series: DTU Aqua Report
Number: 302-2015
ISSN: 1395-8216
Main Research Area: Technical/natural sciences
Electronic versions:

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Publication: Research › Report – Annual report year: 2015
Optimal bæredygtig udnyttelse af tilgængelige torskebestande for dansk fiskeri

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Ecosystem based Marine Management, Section for Marine Living Resources, Section for Marine Ecology and Oceanography, Centre for Ocean Life
Authors: Eero, M. (Intern), Hansen, J. H. (Intern), Hüsey, K. (Intern), Huwer, B. (Intern), Berg, C. W. (Intern), Mariani, P. (Intern), Mosegaard, H. (Intern), Nielsen, A. (Intern), Eg Nielsen, E. (Intern), Rindorf, A. (Intern), Ulrich, C. (Intern), Vinther, M. (Intern), Worsøe Clausen, L. (Intern)
Number of pages: 52
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Place of publication: Charlottenlund
Publisher: DTU Aqua. Institut for Akvatiske Ressourcer
Original language: Danish
Main Research Area: Technical/natural sciences
Publication: Research › Report – Annual report year: 2015

Oxygen minimum zone induced rapid temporal fluctuations of Eastern Baltic cod genetic diversity

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography, Section for Marine Living Resources, Johann Heinrich von Thünen-Institute, Leibniz Institute of Marine Sciences
Authors: Dierking, J. (Ekstern), von Dewitz, B. (Ekstern), Elsbernd, L. (Ekstern), Schultz, H. (Ekstern), Bracamonte, S. (Ekstern), Hüsey, K. (Intern), Hansen, J. H. (Intern), Krumme, U. (Ekstern), Oeberst, R. (Ekstern), Hinrichsen, H. (Ekstern), Reusch, T. (Ekstern)
Publication date: 2015
Event:
Main Research Area: Technical/natural sciences
Bibliographical note
ICES C.M. 2015/Q:22
Publication: Research › Conference abstract for conference – Annual report year: 2015

Processes controlling recruitment in Baltic cod

General information
State: Published
Organisations: National Institute of Aquatic Resources, Institute Management, Section for Marine Ecology and Oceanography, Section for Ecosystem based Marine Management, Leibniz Institute of Marine Sciences
Authors: Köster, F. (Intern), Huwer, B. (Intern), Hinrichsen, H. (Ekstern), Neumann, V. (Intern), Makarchouk, A. (Ekstern), Eero, M. (Intern), Hüsey, K. (Intern), Plikshs, M. (Ekstern)
Publication date: 2015
Event:
Main Research Area: Technical/natural sciences
Bibliographical note
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Publication: Research › Conference abstract for conference – Annual report year: 2015

Stock mixing of eastern and western Baltic cod in SD 24

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography, Section for Marine Living Resources, Section for Ecosystem based Marine Management
Authors: Hüsey, K. (Intern), Mosegaard, H. (Intern), Albertsen, C. M. (Intern), Hansen, J. H. (Intern), Eero, M. (Intern)
Publication date: 2015
Event: Abstract from ICES Annual Science Conference 2015, Copenhagen, Denmark.
Main Research Area: Technical/natural sciences
Bibliographical note
Examining the interactions of growth, climate and recruitment of boarfish (Capros aper) for a better understanding of the recent population expansion

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Monitoring and Data, Section for Marine Ecology and Oceanography
Authors: Davies, J. O. (Intern), Hüsey, K. (Intern)
Publication date: 2014
Event: Abstract from 5th International Otolith Symposium, Mallorca, Spain.
Main Research Area: Technical/natural sciences
Electronic versions:
Examining_the_interactions_of_growth_climate_and_recruitment_of_boarfish_Capros_aper_for_a_better_understanding_of_the_recent_population_expansion.pdf
Publishers version
Links:

Relations
Activities:
Examining the interactions of growth, climate and recruitment of boarfish (Capros aper) for a better understanding of the recent population expansion
Publication: Research › Conference abstract for conference – Annual report year: 2014

Implications of stock recovery for a neighbouring management unit: experience from the Baltic cod
Cod in the Baltic Sea is assessed and managed as two separate stocks, i.e. eastern and western Baltic cod. The eastern Baltic cod has recently started to recover after several decades of severe depletion. In the present study, we suggest that the recovery of the eastern Baltic cod population has also substantially increased cod abundance in a specific area of the adjacent western Baltic management unit. This is investigated through long time-series of spatially resolved stock assessment data supplemented by genetic analyses of origin of the cod currently found in the transition area between the two populations. Due to immigrating cod from the east, there are currently large spatial differences in cod abundance and mean weight in the western Baltic management unit that raise new management concerns. First, the high abundance of cod of eastern origin found in the western Baltic management unit can mask the relatively poor state of the western Baltic cod population. Second, the current fishing mortality estimates for the entire western Baltic management unit, used as basis for fisheries management, are difficult to interpret as these are highly influenced by mixing of biological populations and the spatial distribution of fisheries.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Ecosystem based Marine Management, Section for Marine Living Resources, Section for Marine Ecology and Oceanography
Authors: Eero, M. (Intern), Hansen, J. H. (Intern), Hüsey, K. (Intern)
Pages: 1458-1466
Publication date: 2014
Main Research Area: Technical/natural sciences

Publication information
Journal: ICES Journal of Marine Science
Volume: 71
Issue number: 6
ISSN (Print): 1054-3139
Ratings:
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BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.63
Otolith microchemistry: A useful tool for age validation?

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography
Authors: Hüssy, K. (Intern)
Publication date: 2014
Event: Abstract from 5th International Otolith Symposium, Mallorca, Spain.
Main Research Area: Technical/natural sciences
Links:

Publication: Research › Conference abstract for conference – Annual report year: 2014
The Baltic cod: A case study for testing stock discrimination based on otolith shape analysis in a mixed stock fishery

**General information**
State: Published
Organisations: National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography, National Institute of Aquatic Resources, Section for Marine Living Resources, Section for Ecosystem based Marine Management
Authors: Hüssy, K. (Intern), Mosegaard, H. (Intern), Hansen, J. H. (Intern), Eero, M. (Intern)
Publication date: 2014
Event: Abstract from 5th International Otolith Symposium, Mallorca, Spain.
Main Research Area: Technical/natural sciences
Publication: Research › Conference abstract for conference – Annual report year: 2014

The recent population expansion of boarfish, Capros aper (Linnaeus, 1758): Interactions of climate, growth and recruitment

The objectives of this study were to evaluate whether temperature changes in the Northeast Atlantic influence the growth and recruitment dynamics of boarfish, Capros aper. Two geographically separate areas were examined, 'north' at the northern distribution range west of Ireland and 'south' on the main fishing grounds south of Ireland. No significant differences in length-at-age were observed between the two areas. Interannual otolith growth patterns were similar between the two areas with distinct years of faster and slower growth. In the 'north', no significant relationship between adult growth and temperature was observed, while growth in the 'south' was positively related to temperature up to approximately 16°C, growth rates were suppressed in the years with temperatures above that. Recruitment showed a positive correlation with adult growth the previous year for the Spanish recruitment index only, suggesting spatial connectivity between the Celtic Sea and the Bay of Biscay. The age distributions were similar in both areas and despite the boarfish's longevity of >30 years, are dominated by the age classes corresponding to the years with high recruitment, suggesting that increased recruitment is responsible for the observed stock expansion

**General information**
State: Published
Organisations: National Institute of Aquatic Resources, Section for Monitoring and Data, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography, National Institute of Aquatic Resources, Section for Marine Living Resources, Marine Institute
Authors: Coad, J. O. (Intern), Hüssy, K. (Intern), Farrell, E. (Ekstern), Clarke, M. (Ekstern)
Pages: 463-471
Publication date: 2014
Main Research Area: Technical/natural sciences

**Publication information**
Journal: Journal of Applied Ichthyology
Volume: 30
Issue number: 3
ISSN (Print): 0175-8659
Ratings: BFI (2018): BFI-level 1
A reliable method for ageing of whiting (Merlangius merlangus) for use in stock assessment and management

Accurate age estimation is important for stock assessment and management. The importance of reliable ageing is emphasized by the impending analytical assessment of whiting (Merlangius merlangus) in the Baltic Sea. Whiting is a top predator in the western Baltic Sea, where it is fished commercially although less extensively compared to the North Sea. Although the species is considered one of the most difficult gadoids to age, few efforts have been made to shed light on the ageing problems. The aim of the present study was to identify and validate the 1st winter ring and to examine the visibility of the subsequent winter rings. Microstructure analysis was used to confirm the 1st winter ring. Additionally, otolith growth trajectories were obtained, confirming the allometric growth as seen in many fish species. The method for ageing of whole otoliths presented in this study can be directly implemented in future ageing of whiting otoliths from the Baltic Sea – and potentially also adjacent areas where the conspecifics have similar growth rates.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Ecosystem based Marine Management, Section for Marine Ecology and Oceanography
Authors: Ross, S. D. (Intern), Hüsey, K. (Intern)
Pages: 825-832
Publication date: 2013
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Applied Ichthyology
Volume: 29
Cod recovery as a new challenge for fisheries management: experience from the Baltic Sea

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Ecosystem based Marine Management, Section for Marine Ecology and Oceanography, Section for Marine Living Resources, Institute Management
Authors: Eero, M. (Intern), Hüssy, K. (Intern), Mosegaard, H. (Intern), Hansen, J. H. (Intern), Bastardie, F. (Intern), Köster, F. (Intern)
Publication date: 2013
Main Research Area: Technical/natural sciences
Publication: Research - peer-review › Journal article – Annual report year: 2013
Improved management based on stock identification of eastern and western Baltic cod

The objective of this project was to establish an empirically founded knowledge base for the sustainable exploitation of the western Baltic cod stock by including the complex stock structure and migration patterns.

Stock mapping: Extensive immigration of "Eastern" cod into the Arkona Basin (SD 24) within the "Western" cod's management unit was documented using high-powered genetic tools. The majority (91%) of all spawning fish caught in SD 24 in 2011 were "Eastern" cod and only 9% were from the "Western" stock. The results suggest that the stock structure in the Arkona Basin is highly influenced by mixing of genetically separate stocks.

Trends in mixing: Since the 1980's where cod in SD 24 consisted primarily of "Western" type, the proportion of "Eastern" cod has increased, particularly since 2005. Throughout that period, the immigration of "Eastern" cod into SD 24 consisted primarily of adult, older fish. The changes in biological characteristics (mean size at age, condition and maturity) observed in that area since 2005 are thus a direct consequence of the extensive immigration of "Eastern" cod. As no seasonal signals in stock mixing were observed, the immigration is not associated with a change in "Eastern" cod's spawning behaviour.

Management: The stock mixing proportions were successfully implemented in DTU Aqua's modeling framework for management scenarios. "Eastern" immigrants into SD 24 lead the management procedure to advice for higher TACs that enhance the pressure on the fishing mortality level in SD 22. The fishing mortality level in SD 22 in this situation will need to be lowered i.e. by allocating more effort and catch from SD 22 to SD 24. Higher landings are expected if effort is redirected/re-allocated to SD 24, profiting from the "Eastern" immigrants. By lowering the fishing mortality in SD 22, the SSB in SD 22 is also preserved, which is assumed to be the main source of recruits for the whole "western" stock (i.e. SD 22 + SD 24). In conclusion: Within the frame of this project we showed that substantial immigration "Eastern" cod into SD 24 has occurred and that these stock dynamics should be incorporated in evaluations of future management plans.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography, Section for Ecosystem based Marine Management, Section for Marine Living Resources
Authors: Hüssy, K. (Intern), Bastardie, F. (Intern), Eero, M. (Intern), Hansen, J. H. (Intern), Mosegaard, H. (Intern), Nielsen, J. R. (Intern)
Number of pages: 61
Publication date: 2013

Publication information
Place of publication: Charlottenlund
Publisher: National Institute of Aquatic Resources, Technical University of Denmark
Original language: English

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Number: 265-2013
ISSN: 1395-8216
Main Research Area: Technical/natural sciences
Electronic versions:
265_2013_Improved_management_based_on_stock_identification_of_eastern_and_western_Baltic_cod
Publication: Research › Report – Annual report year: 2013

Individual behaviour of Baltic cod (Gadus morhua) in relation to sex and reproductive state

Information from data storage tags (DSTs) is conventionally used to infer movement patterns or reveal characteristics (e.g. temperature or salinity) of the environment surrounding tagged fish. Here we link data derived from DSTs with the reproductive physiology of tagged fish. Individual vertical activity of adult male and female Atlantic cod Gadus morhua L. in the Bornholm Basin was derived from DST measures and related to the individual histologically determined reproductive phase. Spawning migrations were identified by movements towards deeper and more saline waters. No difference was observed between sexes in the timing of the onset of migration and the duration of migration from feeding grounds to the spawning area. While there was no significant difference in duration of the spawning period between females and males, the histological indices suggest that females finish spawning before males. Irrespective of gender, vertical swimming activity was most pronounced during spawning, with descents towards the bottom dominating the movements. During spawning, males stayed significantly deeper than females. In conclusion, the present results suggest that initiation of spawning migration and duration of the spawning period differs between sexes, as does the level of activity during spawning events. Not all individuals followed the general pattern; a considerable number of individuals were found to spawn in shallow water in the Arkona Basin, and juvenile fish undertook the migration without spawning

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography
Authors: Nielsen, B. (Ekstern), Hüssy, K. (Intern), Neuenfeldt, S. (Intern), Tomkiewicz, J. (Intern), Behrens, J. (Intern), Andersen, K. H. (Intern)
Pages: 197-207
Spawning migration and behavior of Baltic cod (Gadus morhua) based on DST-derived individual information

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography
Authors: Behrens, J. (Intern), Nielsen, B. (Ekstern), Hüssy, K. (Intern), Neuenfeldt, S. (Intern), Andersen, K. H. (Intern), Tomkiewicz, J. (Intern)
Publication date: 2013
Main Research Area: Technical/natural sciences
Publication: Research - peer-review » Journal article – Annual report year: 2013

Boom in boarfish abundance: insight from otolith analysis
The boarfish Capros aper is a pelagic shoaling species widely distributed along the Northeast Atlantic continental shelf. In recent years, this species has experienced a dramatic boom in abundance in the Bay of Biscay and Celtic Sea. This study aims at resolving the mechanisms responsible for this increase in stock size. Based on annual otolith growth increments, we developed a growth chronology as a proxy for stock fecundity. Growth patterns were similar
between geographically separate areas west and south of Ireland, with distinct years of good and bad growth. Good growth was observed in 2004 and 2008, while 2005 was exceptionally bad. In the northernmost areas, growth was significantly influenced by autumn temperatures and food availability, while growth south of Ireland was only influenced by summer temperatures. These months are the primary growing season of the boarfish. Year-class strength was not correlated with growth in the same year. However, year-class strength was significantly correlated with adult growth the previous year, together with temperature during the months following spawning. The age structure shows that this species is very long lived (>30 years), but that a considerable proportion of fish are only aged 4–6 years. These age classes correspond to the year with exceptionally high recruitment. This study has demonstrated that both adult growth as a proxy for reproductive potential and environmental conditions favouring early life stage survival may be the cause for the boom in boarfish abundance.

**General information**

State: Published
Organisations: National Institute of Aquatic Resources, Section for Monitoring, Section for Population Ecology and Genetics
Authors: Coad, J. O. (Intern), Hüsey, K. (Intern)
Number of pages: 24
Publication date: 2012
Event: 
Main Research Area: Technical/natural sciences

**Hydrographic influence on the spawning habitat suitability of western Baltic cod (Gadus morhua)**

Hydrographic influence on the spawning habitat suitability of western Baltic cod (Gadus morhua) – ICES Journal of Marine Science, 69: 1736–1743. Recruitment variability of marine fish is influenced by the reproductive potential of the stock (i.e. stock characteristics and abundance) and the survival of early life stages, mediated by environmental conditions of both a physical (water temperature, salinity and oxygen conditions, ocean currents) and a biological nature (i.e. food, predators). The objective of this study is to assess the importance of variability in environmental conditions within different western Baltic cod spawning grounds for egg survival. Habitat identification was based on environmental threshold levels for egg survival and development and ambient hydrographical conditions at different times during the spawning season. The long-term resolution of environmental conditions allowing survival of western Baltic cod eggs indicates that favourable conditions predominantly occurred during the late spawning season in April/May, while minimum survival rates could be expected from January to March. Unsuitable time periods and habitats exhibiting the highest mortality rates are exclusively characterized by ambient water temperatures below the critical survival threshold. Despite the strong influence of water temperature on habitat suitability, the impact of habitat suitability on recruitment was not clearly defined, suggesting that other mechanisms regulate year class strength.

**General information**

State: Published
Organisations: National Institute of Aquatic Resources, Section for Population Ecology and Genetics, GEOMAR - Helmholtz Centre for Ocean Research Kiel
Authors: Hüsey, K. (Intern), Hinrichsen, H. (Ekstern), Huwer, B. (Intern)
Pages: 1736-1743
Publication date: 2012
Main Research Area: Technical/natural sciences

**Publication information**

Journal: ICES Journal of Marine Science
Volume: 69
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Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.63
Web of Science (2016): Indexed yes
Oocyte development and maturity classification of boarfish (Capros aper) in the Northeast Atlantic

Oocyte development and maturity classification of boarfish (Capros aper) in the Northeast Atlantic. – ICES Journal of Marine Science, 69: 498–507. This study presents the first detailed investigation of the oocyte development and maturity classification of boarfish, Capros aper, which has recently become the target of an industrial fishery in the Northeast Atlantic. A total of 2014 boarfish were collected from January to December 2010. Mature male and female boarfish were sexually dimorphic and could be readily identified based on external characteristics. A comprehensive maturity scale was developed, which indicated that the length at 50% maturity for males and females was 9.7 cm total length. Female boarfish were observed to spawn in Irish waters in June and July. Once spawning ceased the remaining mature oocytes were resorbed. Preliminary analysis of reproductive strategy indicates that the boarfish is likely an asynchronous batch spawner with indeterminate fecundity.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Population Ecology and Genetics, Marine Institute
Authors: Farrell, E. D. (Ekster), Hüssy, K. (Intern), Coad, J. O. (Intern), Worsøe Clausen, L. (Intern), Clarke, M. W. (Ekster)
Pages: 498-507
Publication date: 2012
Optimization of fisheries resource exploitation in the Skagerrak (Oskar)
Otolith microstructure analysis to resolve seasonal patterns of hatching and settlement in western Baltic cod

Previous studies showed that Baltic cod (Gadus morhua) settle to demersal life at a given size, while the annulus is formed seasonally, irrespective of size. The goal of this study was to examine the timing of check formation in juvenile Baltic cod otoliths to validate macrostructural ageing and to differentiate between true annuli and secondary structures such as settlement checks. Otoliths were collected from fish off Fehmarn Island in 2008 and 2009, and were examined for macrostructural and microstructural patterns using light and scanning electron microscopy. All fish examined were age-0. Back-calculation of hatch dates indicated hatching from April to June and from February to August in 2008 and 2009, respectively. Juveniles formed either one or two translucent rings. The first translucent ring started to form ∼3 months post-hatch and was interpreted as a settlement check, since it appeared to be a function of age and/or size and not season. Deposition of the second ring began in mid October to early November irrespective of fish size and/or age, thus indicating that this ring may represent the first annulus of Baltic cod. Both rings were clearly distinguishable in individuals hatched between February and May, but were merged in those fish where settlement coincided with the seasonally formed second ring.
Sexual dimorphism in size, age, maturation, and growth characteristics of boarfish (Capros aper) in the Northeast Atlantic

Sexual dimorphism in size, age, maturation, and growth characteristics of boarfish (Capros aper) in the Northeast Atlantic – ICES Journal of Marine Science, 69: 1729-1735. Boarfish (Capros aper) have, in recent years, become of increasing commercial importance due to their apparent increase in abundance in the Northeast Atlantic. This study presents detailed biological information relevant to understanding stock structure and dynamics. Boarfish are a long-lived species that reach a maximum age of >30 years. The size distribution is skewed towards larger sizes, as expected from an unexploited stock with sexual dimorphism, where females are, on average, larger than males. No seasonal effects occur in size distribution and sex ratio, indicating that females and males stay together in shoals throughout the year. Females become increasingly dominant in abundance at larger sizes and older ages. There is no significant difference in length at maturity nor age at maturity between the two sexes, with L50 = 9.7 cm and A50 = 3.4 years. Growth is dimorphic following von Bertalanffy growth characteristics, with a common t = −2.897, but significantly different K and Linf values, where females have K =
0.145 and Linf = 16.519 and males have K = 0.181 and Linf = 14.437. The sexual dimorphism in size is thus caused by sex-specific growth and longevity patterns

**General information**

State: Published
Organisations: National Institute of Aquatic Resources, Section for Population Ecology and Genetics, Section for Monitoring, Marine Institute
Authors: Hüsey, K. (Intern), Coad, J. O. (Intern), Farrell, E. D. (Ekstern), Worsøe Clausen, L. (Intern), Clarke, M. W. (Ekstern)
Pages: 1729-1735
Publication date: 2012
Main Research Area: Technical/natural sciences

**Publication information**

Journal: ICES Journal of Marine Science
Volume: 69
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Web of Science (2018): Indexed yes
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Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.63
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 2.18
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 2.62
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 2.46
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 2.35
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 2.32
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Web of Science (2008): Indexed yes
Web of Science (2007): Indexed yes
Web of Science (2006): Indexed yes
Web of Science (2005): Indexed yes
Web of Science (2004): Indexed yes
Web of Science (2003): Indexed yes
Web of Science (2002): Indexed yes
Web of Science (2001): Indexed yes
Spatio-temporal variability in western Baltic cod early life stage survival mediated by egg buoyancy, hydrography and hydrodynamics.

Spatio-temporal variability in western Baltic cod early life stage survival mediated by egg buoyancy, hydrography and hydrodynamics. – ICES Journal of Marine Science, 69: 1744–1752. To disentangle the effects of different drivers on recruitment variability of marine fish, a spatially and temporally explicit understanding of both the spawning stock size and the early life stage dynamics is required. The objectives of this study are to assess the transport of western Baltic cod early life stages as well as the variability in environmentally-mediated survival along drift routes in relation to both spatial (within and between different spawning areas) and temporal (interannual and seasonal) dynamics. A spatially and temporally highly-resolved biophysical model of the Baltic Sea was used to describe mortalities and survival success of eggs and yolk-sac larvae—represented by individual, virtual drifters—as predicted proportions of drifters that either died due to bottom contact or lethal temperatures, or that survived up to the end of the yolk-sac larval stage. The environmental conditions allowing survival of cod and yolk-sac larvae indicate that favourable conditions predominately occurred during the late spawning season, while minimum survival rates could be expected from January to March. The spatial analysis of different spawning areas revealed highest survival chances in the Kattegat, intermediate survival in the Great Belt, and only low survival in the Sound, Kiel Bay and Mecklenburg Bay.
Suitability of otolith microchemistry for stock separation of Baltic cod

Microchemical otolith analyses have been shown to provide valuable information on the life history, dispersal and stock characteristics of teleost fish. In the present study, the suitability of this technique for identifying the origin and distribution of Atlantic cod Gadus morhua L. from the Baltic Sea was examined using laser ablation-ICPMS. The capacity to distinguish individuals from different Baltic Sea stocks and from the adjacent North Sea stock based on incorporation of stock-specific elemental fingerprints along otolith growth axes was investigated. It was further tested if different origins led to spawning-site specific element concentrations in otolith cores. The results indicate that microchemical analyses of Baltic cod otoliths are applicable for differentiating individuals of different stocks. Analyses of similarities including 12 element/calcium ratios resulted in significant differences between individuals from the eastern and the western Baltic Sea and between North Sea and Baltic Sea samples. Sr/Ca, Ba/Ca, Y/Ca, Mg/Ca, Zr/Ca and Mn/Ca ratios had the strongest discriminatory power. A further separation of individuals caught in 3 different spawning grounds of the eastern Baltic, however, was not possible. Elemental compositions from the core regions of otoliths from young of the year cod caught in eastern and western Baltic Sea spawning grounds showed significant differences in Sr/Ca, Ba/Ca and Mg/Ca concentrations. Analyses of similarities again showed significant differences between these areas for juveniles. This study demonstrates the potential of otolith microchemical analyses to provide important information about the stock structure and connectivity of G. morhua in the Baltic Sea.
10.000 kr. i dusør for mærkede torsk i Østersøen

General information
State: Published
Organisations: Section for Monitoring, National Institute of Aquatic Resources, Section for Coastal Ecology, Section for Population Ecology and Genetics
Authors: Storr-Paulsen, M. (Intern), Sparrevohn, C. R. (Intern), Hüssy, K. (Intern)
Pages: 9
Publication date: 2011
Age verification of boarfish (Capros aper) in the Northeast Atlantic

General information
State: Published
Organisations: Section for Population Ecology and Genetics, National Institute of Aquatic Resources
Authors: Hüssy, K. (Intern), Coad, J. O. (Intern), Farrell, E. D. (Ekstern), Worsøe Clausen, L. (Intern), Clarke, M. W. (Ekstern)
Pages: 34-40
Publication date: 2011
Main Research Area: Technical/natural sciences

Publication information
Journal: I C E S Journal of Marine Science
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Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.63
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 2.18
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 2.62
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 2.46
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 2.35
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 2.32
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Review of western Baltic cod (Gadus morhua) recruitment dynamics

Important processes in the recruitment dynamics of western Baltic cod (Gadus morhua) are identified. Spawning areas are in the deep, saline waters below 20–40 m, depending on area topography. Spatial distribution remains relatively stable over time. Peak spawning shows an area-specific pattern, with progressively later spawning towards the east. Genetic stock structure and tagging indicate some degree of natal homing for spawning. The highly variable hydrodynamic conditions and the fact that cod eggs float in the water column cause their entrainment by currents, and their destination is determined by the prevailing winds and currents. Drift is almost exclusively to the east, but the magnitude and its impact on the structure of the affected stocks (Kattegat, western Baltic, and eastern Baltic) remains unresolved. Salinity limits the east–west exchange of eggs as a consequence of the stocks' differential requirement for neutral buoyancy. Superimposed on this, oxygen content and temperature have a significant effect on fertilization, egg/larva development, and survival. Within the Baltic Sea ecosystem, mixing of stocks may be anticipated and is particularly pronounced in the Arkona Basin because of its use for spawning by both western and eastern stocks, the advection of early life stages from the west and immigration/emigration from the east.
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 2.46
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 2.35
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 2.32
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
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Web of Science (2007): Indexed yes
Web of Science (2006): Indexed yes
Web of Science (2005): Indexed yes
Web of Science (2004): Indexed yes
Web of Science (2003): Indexed yes
Web of Science (2002): Indexed yes
Web of Science (2001): Indexed yes
Web of Science (2000): Indexed yes
Original language: English
DOIs:
10.1093/icesjms/fsr088
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Publication: Research - peer-review › Journal article – Annual report year: 2011

The impact of hydrodynamics and hydrography on western Baltic cod early life stage survival

General information
State: Published
Organisations: Section for Population Ecology and Genetics, National Institute of Aquatic Resources
Authors: Hinrichsen, H. (Ekstern), Hüsey, K. (Intern), Huwer, B. (Intern)
Publication date: 2011
Main Research Area: Technical/natural sciences
Electronic versions:
L0211.pdf
Links:
http://www.ices.dk/products/CMdocs/CM-2011/L/L0211.pdf
Source: orbit
Source-ID: 277471
Publication: Research - peer-review › Journal article – Annual report year: 2011

Does DNA extraction affect the physical and chemical composition of historical cod (Gadus morhua) otoliths?
Archived otoliths constitute an important source of historical DNA for use in temporal genetic studies, but such otoliths are also valuable for other research applications, e.g. growth or microchemistry studies, where information about the past is of relevance. Consequently, there are potentially conflicting interests regarding how the limited and irreplaceable otolith collections should be used. To resolve this, it is important to find out whether DNA extraction damages otoliths such that they can no longer be used for other research purposes or whether individual otoliths can be used in multiple applications. We examined the effects of three different DNA extraction methods on the elemental composition, the morphology, and the clarity of annual growth increments for successful age estimation of Atlantic cod (Gadus morhua) otoliths that had
been archived for 0–31 years. The three extraction methods yielded DNA of comparable quality, and none of the methods caused major damage to the otoliths. Of the element concentrations measured, only Mg and Rb showed considerable changes resulting from DNA extraction. The physical properties of the otolith (morphology and clarity of annual growth increments) were not affected. Hence, cod otoliths can be used for several research purposes after DNA extraction.

**General information**

*State:* Published  
*Organisations:* Section for Population Ecology and Genetics, National Institute of Aquatic Resources  
*Authors:* Therkildsen, N. O. (Intern), Eg Nielsen, E. (Intern), Hüssy, K. (Intern), Meldrup, D. (Intern), Geffen, A. J. (Ekstern)  
*Pages:* 1251-1259  
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Web of Science (2017): Indexed yes  
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Scopus rating (2016): CiteScore 2.63  
Web of Science (2016): Indexed yes  
BFI (2015): BFI-level 1  
Scopus rating (2015): CiteScore 2.18  
Web of Science (2015): Indexed yes  
BFI (2014): BFI-level 1  
Scopus rating (2014): CiteScore 2.62  
Web of Science (2014): Indexed yes  
BFI (2013): BFI-level 1  
Scopus rating (2013): CiteScore 2.46  
ISI indexed (2013): ISI indexed yes  
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ISI indexed (2012): ISI indexed yes  
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Scopus rating (2011): CiteScore 2.32  
ISI indexed (2011): ISI indexed yes  
Web of Science (2011): Indexed yes  
BFI (2010): BFI-level 1  
Web of Science (2010): Indexed yes  
BFI (2009): BFI-level 1  
Web of Science (2009): Indexed yes  
BFI (2008): BFI-level 2  
Web of Science (2008): Indexed yes  
Web of Science (2007): Indexed yes  
Web of Science (2006): Indexed yes  
Web of Science (2005): Indexed yes  
Web of Science (2004): Indexed yes  
Web of Science (2003): Indexed yes  
Web of Science (2002): Indexed yes  
Web of Science (2001): Indexed yes
Thermal niche of Atlantic cod Gadus morhua: limits, tolerance and optima

Recent studies in the marine environment have suggested that the limited phenotypic plasticity of cold-adapted species such as Atlantic cod Gadus morhua L. will cause distributions to shift toward the poles in response to rising sea temperatures. Some cod stocks are predicted to collapse, but this remains speculative because almost no information is available on the thermal tolerance of cod in its natural environment. We used electronic tags to measure the thermal experience of 384 adult Atlantic cod from 8 different stocks in the northeast Atlantic. Over 100000 d of data were collected in total. The data demonstrate that cod is an adaptable and tolerant species capable of surviving and growing in a wide range of temperate marine climates. The total thermal niche ranged from −1.5 to 19°C; this range was narrower (1 to 8°C) during the spawning season. Cod in each of the stocks studied had a thermal niche of approximately 12°C, but latitudinal differences in water temperature meant that cod in the warmer, southern regions experienced 3 times the degree days (DD; ~4000 DD yr⁻¹) than individuals from northern regions (~1200 DD yr⁻¹). Growth rates increased with temperature, reaching a maximum in those cod with a mean thermal history of between 8 and 10°C. Our direct observations of habitat occupation suggest that adult cod will be able to tolerate warming seas, but that climate change will affect cod populations at earlier life-history stages as well as exerting effects on cod prey species.

General information
State: Published
Organisations: Section for Population Ecology and Genetics, National Institute of Aquatic Resources
Authors: Righton, D. A. (Ekstern), Andersen, K. H. (Intern), Neat, F. (Ekstern), Thorsteinsson, V. (Ekstern), Steingrund, P. (Ekstern), Svedäng, H. (Ekstern), Michelsen, K. (Ekstern), Hinrichsen, H. (Ekstern), Bendall, V. (Ekstern), Neuenfeldt, S. (Intern), Wright, P. (Ekstern), Jonsson, P. (Ekstern), Huse, G. (Ekstern), van der Kooij, J. (Ekstern), Mosegaard, H. (Intern), Hüssy, K. (Intern), Metcalfe, J. (Ekstern)
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BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
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Scopus rating (2016): CiteScore 2.4
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 2.56
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 2.75
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 2.79
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 2.9
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
The use of otolith microstructure to estimate age in adult Atlantic cod Gadus morhua

Transverse sections of otoliths from Atlantic cod Gadus morhua from the Baltic Sea revealed narrow growth increments. The widths of these increments corresponded to daily increments from fish with known otolith growth rates and were therefore assumed to be daily increments. They exhibited a distinct pattern with increasing distance from the primary primordium. A series of zones with clearly distinguishable increments, first with increasing then with decreasing widths in a dome-shaped pattern, were separated by zones where no regular increment structure was visible. Increment width seemed to be tightly coupled to the annual cycle in environmental temperature at a depth of 30–60 m, where G. morhua predominantly reside. Between 135 and 200 increments occurred within the different zones, with a non-significant trend towards lower increment numbers and widths with distance from the primary primordium of the otolith. Increment formation apparently ceased at temperatures <5–6° C, but growth during the cold months corresponded closely with estimated growth rates. The increment patterns seemed to reflect annual cycles in environmental temperature, and the count of the increment cycles may thus be a promising tool for the determination of the true age of Baltic G. morhua.

General information
State: Published
Organisations: Section for Population Ecology and Genetics, National Institute of Aquatic Resources
Authors: Hüssy, K. (Intern), Hinrichsen, H. (Ekstern), Fey, D. (Ekstern), Walther, Y. (Ekstern), Velasco, A. (Ekstern)
Pages: 1640-1654
Publication date: 2010
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Fish Biology
Volume: 76
Issue number: 7
ISSN (Print): 0022-1112
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Why is age determination of Baltic cod (Gadus morhua) so difficult?
The aim of this study was to evaluate the consistency of three methods for assigning annuli in adult Baltic cod otoliths. The methods examined were (i) daily increment patterns, (ii) opacity profiles, and (iii) traditional age reading. Frequency distributions of the distance from the nucleus to the different zones showed that the first annulus of traditional age reading missed the first zone of both increment and opacity methods, but overlapped with the second zone identified by these methods. This pattern did not continue over subsequent zones. Frequency distributions of increment patterns were similar to opacity patterns. However, within individual fish, the co-occurrence of overlap between the two patterns was random. In cases where there was overlap, translucent zone formation started just before the disappearance of visible increments. Overlap in 1 year did not necessarily lead to a consistent pattern the following year, and overlap was not influenced by sex or fish size. The results suggest that otolith opacity in Baltic cod is not associated with seasonal patterns in daily increment structure and that traditional age determination based on otolith opacity yields highly uncertain estimates of age.
Automated Fish Ageing (AFISA)

General information
State: Published
Organisations: Section for Population- and Ecosystem Dynamics, National Institute of Aquatic Resources
Authors: Mahe, K. (Ekstern), Ogor, A. (Ekstern), Hüssy, K. (Intern), Christensen, A. (Intern), Mosegaard, H. (Intern),
Warens, S. (Ekstern), De Pontual, H. (Ekstern), Harbitz, A. (Ekstern), Gudmundsson, E. (Ekstern), Thordarson, G. (Ekstern), Parisi, V. (Ekstern), Cotano, A. (Ekstern), Carbini, S. (Ekstern)
Publication date: 2009

Publication information
Original language: English
Main Research Area: Technical/natural sciences

Bibliographical note
(AFISA, proj. nr. 2243). FP6 project, Specifically targeted research project of innovation project - Reference no 044132

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Publication: Research › Report – Annual report year: 2009

Cod spatial dynamics and vertical movements in European waters and implications for fishery management (CODYSSEY)

General information
State: Published
Organisations: Section for Population- and Ecosystem Dynamics, National Institute of Aquatic Resources
Authors: Righton, D. (Ekstern), Metcalfe, J. (Ekstern), McCloghrie, P. (Ekstern), Hetherington, S. (Ekstern), Mills, C. (Ekstern), Kobij, J. V. D. (Ekstern), Michelsen, K. (Ekstern), Fernø, A. (Ekstern), Huse, G. (Ekstern), Ádlandsvik, B. (Ekstern), Subby, S. (Ekstern), Quayle, V. (Ekstern), Aldridge, J. (Ekstern), Little, A. (Ekstern), Heffernan, O. (Ekstern), Neuenfeldt, S. (Intern), Mosegaard, H. (Intern), Beyer, J. (Intern), Andersen, N. G. (Intern), Andersen, K. H. (Intern), Worsøe Clausen, L. (Intern), Hüssy, K. (Intern), Nielsen, B. (Intern), Wright, P. (Ekstern), Neat, F. (Ekstern), Gibb, I. (Ekstern), Gibb, F. (Ekstern), Zuur, A. (Ekstern), Thorsteinsson, V. (Ekstern), Valdimarsson, H. (Ekstern), Palsson, O. (Ekstern), Saemundsson, K. (Ekstern), Strand, E. (Ekstern), Hinrichsen, H. (Ekstern), Kraus, G. (Ekstern), Lehmann, A. (Ekstern), Schaber, M. (Ekstern), Steingrund, P. (Ekstern), Svedang, H. (Ekstern), Jonsson, P. (Ekstern)
Publication date: 2009

Publication information
Original language: English
Main Research Area: Technical/natural sciences

Bibliographical note
CODYSSEY FP5 QOL shared-cost rtd EU project - Reference no QLRT-2001-00813)

Source: orbit
Source-ID: 252555
Publication: Research › Report – Annual report year: 2009

ImproveD mEthodology for Baltic COD age Estimation (DECODA)
Using data storage tags to link otolith macrostructure in Baltic cod Gadus morhua with environmental conditions

We examined otolith opacity of Baltic cod in relation to environmental conditions in order to evaluate the formation mechanisms of seasonal patterns used in age determination. Adult fish were tagged with data storage tags (DSTs) and a permanent mark was induced in the otoliths by injection of a strontium chloride solution. Based on environmental conditions experienced, fish were classified into different behavioural types: non-reproducing 'non-spawner', and 'spawner' undertaking spawning migrations. Otolith opacity, an indicator of otolith and fish somatic growth and condition, was examined in relation to these environmental drivers. Temperature was the only environmental variable with a significant effect, overlaying a strong size-related effect. The temperature effect was not uniform across behavioural types and spawning periods. Opacity showed a negative correlation with temperature as expected—but in non-spawning fish only. In spawners, the general trend was a decrease in opacity from pre- to post spawning. A significant - but positive - temperature effect was only found in the pre-spawning period. The negative effects during and following spawning were not significant. In spawners, this decoupling leads to an otolith structure with stronger contrasts and more abrupt changes, while in non-spawners, opacity changes more smoothly. The trigger for this decoupling seems to be an interaction between temperature exposure and seasonal variations in food availability and may serve as a tool to identify the occurrence and repetitiveness of spawning in Baltic cod.
Using otolith microstructure to infer age of adult Eastern Baltic cod (Gadus morhua L.)

General information
State: Published
Organisations: Section for Population- and Ecosystem Dynamics, National Institute of Aquatic Resources
Authors: Hüssy, K. (Intern), Mosegaard, H. (Intern)
Publication date: 2009
Event: Abstract from 4. International Symposium on Fish Otolith Research & Application, Monterrey, California, USA.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 229402
Publication: Research - peer-review › Journal article – Annual report year: 2009

Otolith accretion rates: Does size really matter?

General information
State: Published
Organisations: Section for Population- and Ecosystem Dynamics, National Institute of Aquatic Resources
Authors: Hüssy, K. (Intern)
Pages: 131-136
Publication date: 2008
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Experimental Marine Biology and Ecology
Volume: 362
Issue number: 2
ISSN (Print): 0022-0981
Ratings:
Otolith shape in juvenile cod (Gadus morhua): Ontogenetic and environmental effects

General information
State: Published
Organisations: Section for Population- and Ecosystem Dynamics, National Institute of Aquatic Resources
Authors: Hüsey, K. (Intern)
Pages: 35-41
Publication date: 2008
Main Research Area: Technical/natural sciences

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- BFI (2017): BFI-level 1
- Web of Science (2017): Indexed yes
- BFI (2016): BFI-level 1
- Scopus rating (2016): CiteScore 2.03 SJR 0.937 SNIP 0.914
- Web of Science (2016): Indexed yes
- BFI (2015): BFI-level 1
- Scopus rating (2015): SJR 1.043 SNIP 0.823 CiteScore 1.87
- Web of Science (2015): Indexed yes
- BFI (2014): BFI-level 1
- Scopus rating (2014): SJR 1.145 SNIP 1.045 CiteScore 2.41
- Web of Science (2014): Indexed yes
- BFI (2013): BFI-level 2
- Scopus rating (2013): SJR 1.294 SNIP 1.08 CiteScore 2.45
- ISI indexed (2013): ISI indexed yes
- Web of Science (2013): Indexed yes
- BFI (2012): BFI-level 2
- Scopus rating (2012): SJR 1.186 SNIP 1.021 CiteScore 2.27
- ISI indexed (2012): ISI indexed yes
- Web of Science (2012): Indexed yes
- BFI (2011): BFI-level 2
- Scopus rating (2011): SJR 1.067 SNIP 1.007 CiteScore 2.14
- ISI indexed (2011): ISI indexed yes
- Web of Science (2011): Indexed yes
- BFI (2010): BFI-level 2
- Scopus rating (2010): SJR 1.239 SNIP 1.017
- Web of Science (2010): Indexed yes
- BFI (2009): BFI-level 2
- Scopus rating (2009): SJR 1.299 SNIP 1.208
- Web of Science (2009): Indexed yes
- BFI (2008): BFI-level 1
- Scopus rating (2008): SJR 1.26 SNIP 1.134
- Web of Science (2008): Indexed yes
- Scopus rating (2007): SJR 1.214 SNIP 1.308
- Web of Science (2007): Indexed yes
Pelagic habitat mapping: A tool for area-based fisheries management in the Baltic Sea

General information
State: Published
Organisations: National Veterinary Institute, Section for Software and GIS development, National Institute of Aquatic Resources, Section for Population- and Ecosystem Dynamics, Section for Monitoring, Institute Management, Section for Ocean Ecology and Climate, Section for Management Systems
Number of pages: 71
Publication date: 2007

Publication information
Publisher: BALANCE
Original language: English

Series: BALANCE interim report
Number: 20
Main Research Area: Technical/natural sciences
Links:
Source: orbit
Source-ID: 224973
Publication: Research › Report – Annual report year: 2007

Atlantic cod (Gadus morhua) growth and otolith accretion characteristics modelled in a bioenergetics context

General information
State: Published
Organisations: Section for Population- and Ecosystem Dynamics, National Institute of Aquatic Resources
Authors: Hüsy, K. (Intern), Mosegaard, H. (Intern)
Pages: 1021-1031
Publication date: 2004
Main Research Area: Technical/natural sciences

Publication information
Journal: Canadian Journal of Fisheries and Aquatic Sciences
Volume: 61
Effect of age and temperature on amino acid composition and the content of different protein types of juvenile cod (Gadus morhua L.) otoliths

General information
State: Published
Organisations: Section for Population- and Ecosystem Dynamics, National Institute of Aquatic Resources, Section for Aquatic Protein Biochemistry
Authors: Hüssy, K. (Intern), Mosegaard, H. (Intern), Jessen, F. (Intern)
Pages: 1012-1020
Publication date: 2004
Main Research Area: Technical/natural sciences

Publication information
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Scopus rating (2016): CiteScore 2.56 SJR 1.322 SNIP 1.163
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.256 SNIP 1.051 CiteScore 2.22
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.443 SNIP 1.379 CiteScore 2.6
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.421 SNIP 1.081 CiteScore 2.25
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.324 SNIP 1.196 CiteScore 2.29
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.423 SNIP 1.09 CiteScore 2.13
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.425 SNIP 1.118
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.451 SNIP 1.196
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 1.589 SNIP 1.379
Web of Science (2008): Indexed yes
Factors determining variations in otolith microincrement width of demersal juvenile Baltic cod Gadus morhua

Pelagic and demersal juvenile Baltic cod Gadus morhua L. were collected on the slope and the top of Rønne bank in the Baltic Sea during 2 cruises in November and December 1998. The objective of this study was to evaluate distinct changes in otolith increment width observed in demersal juveniles by comparison with laboratory-reared individuals, and to investigate the factors determining variation in these increments. The different increment-width patterns were identified with a method based on the widths of consecutive increments. Otolith increment widths of juvenile cod were found to be highly variable within and between individuals, in both the experimental and the field samples. The first change in increment pattern observed in the field samples was related to settling. The formation periodicity of increments within the different pattern intervals was confirmed with a growth model based on otolith growth rates of juvenile cod reared in the laboratory under different conditions. In this model, otolith growth rate was expressed as a function of rearing temperature and fish dry weight. Otolith growth of the field samples was calculated using ambient temperatures obtained from a 3D-circulation model. The best fit to observed otolith growth rates was obtained under the assumption that fish on the slope performed daily vertical migrations between the warm surface layer and the cold bottom layer. The data suggested that fish stayed in the surface layer during the first increment-pattern interval, performed vertical migrations during the second interval, and stayed in association with the seafloor in the subsequent interval, corresponding to the time after the breakdown of the thermocline.

General information
State: Published
Organisations: Section for Population- and Ecosystem Dynamics, National Institute of Aquatic Resources
Authors: Hüsey, K. (Intern), Mosegaard, H. (Intern), Hinrichsen, H. (Ekstern), Böttcher, U. (Ekstern)
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Publication date: 2003
Main Research Area: Technical/natural sciences

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Pelagic and demersal juvenile Baltic cod Gadus morhua L. were collected on the slope and the top of Rønne bank in the Baltic Sea during 2 cruises in November and December 1998. The growth, age at settling and vertical migration pattern were studied by otolith microstructure analysis. The relationship between fish and otolith size were found to change at settling, with an increase of fish size in relation to otolith size after settling. This change was more pronounced on the slope compared to the top of the bank. The timing of first settling at the 2 localities did not differ with respect to fish age. At both localities, fish that hatched early in the season spent a shorter time in the pelagic stage than late-hatched fish. However, significant differences in growth rate during the pelagic stage were observed, where fish captured on the slope grew faster. On the bank, individuals with fast otolith growth rates before settling continued to grow fast after settling. On the slope, no relationship between growth before and after settling was found. These results indicate that the different settling habitats occupied by juvenile Baltic cod have different potential for settling and nursery areas.
Baltic cod: Resolving processes determining spatial and temporal windows of survival

General information
State: Published
Organisations: Section for Population- and Ecosystem Dynamics, National Institute of Aquatic Resources, Institute Management, Section for Management Systems, Technical University of Denmark
Authors: St John, M. A. (Ekstern), Mosegaard, H. (Intern), Hinrichsen, H. (Ekstern), Grønkjær, P. (Ekstern), Köster, F. (Intern), Hüssy, K. (Intern), Nielsen, J. R. (Intern)
Pages: 1-25
Publication date: 2000
Main Research Area: Technical/natural sciences

Backcalculating Baltic cod size at age from otolith measurements

General information
State: Published
Organisations: Section for Population- and Ecosystem Dynamics, National Institute of Aquatic Resources, Section for Coastal Ecology
Authors: Mosegaard, H. (Intern), Hüssy, K. (Intern), Sparrevohn, C. R. (Intern)
Publication date: 1997
Main Research Area: Technical/natural sciences

Food resource utilization by juvenile Baltic cod Gadus morhua: a mechanism potentially influencing recruitment success at the demersal juvenile stage?

Pelagic and demersal juvenile Baltic cod Gadus morhua L. were collected during surveys in the Bornholm Basin (Baltic Sea) in autumn 1994. Stomach contents were examined for prey composition in order to evaluate the potential importance of the pelagic and demersal habitats for recruitment success. Juvenile cod less than 40 mm fed exclusively on pelagic prey such as copepods and cladocerans. Between 40 and 50 mm the juveniles began to consume benthic prey such as mysids and amphipods; however, copepods were still the dominant food organisms. Between 50 and 70 mm the dominant prey items consumed were mysids and amphipods, with copepods comprising a minor component of the diet. Between 70 and 160 mm the juveniles’ diet was composed exclusively of benthic prey with an increase in prey diversity. Mysids were slightly less important in the diet, while the abundance of polychaetes, decapods and fish increased with fish size. Amphipods remained almost constant in the diet of juveniles above 60 mm in length. These results indicate that a major change in food resource utilization started to occur at a fish length of 40 mm, with the main change taking place at
approximately 50 mm, suggesting that juvenile Baltic cod make the transition to the benthic habitat at this length. This change in food preference is also reflected in the size of the prey items and the numbers of prey consumed. Pelagic juveniles consumed much smaller prey than their demersal conspecifics. Neither prey size nor prey numbers consumed by pelagic and small demersal juveniles from this study differed from prey reported to be taken by juvenile cod of corresponding size in the Atlantic and the North Sea. However, prey organisms consumed by demersal juvenile Baltic cod larger than 90 mm were much smaller, and prey numbers much higher, than those reported to be consumed by juveniles in other areas. The apparent overlap in food resource utilization among the different size groups of demersal juveniles observed in this study suggests that in years with low prey abundance, or high abundance of pelagic juveniles, strong intra-specific competition for food resources may affect the recruitment success of Baltic cod.
Otolith micro-structure pattern as an indicator of environmental and fish condition of Baltic cod at settling

General information
State: Published
Organisations: Section for Population- and Ecosystem Dynamics, National Institute of Aquatic Resources
Authors: Mosegaard, H. (Intern), St John, M. (Ekstern), Hüssy, K. (Intern)
Publication date: 1995
Main Research Area: Technical/natural sciences

Publication information
Journal: ICES CM 1995/
Volume: G:37
Original language: English
Source: orbit
Source-ID: 226693
Publication: Research › Conference article – Annual report year: 1995

Preliminary observations of a size at settling and food resource utilization of juvenile (O-group) Baltic cod (Gadus morhua)

General information
State: Published
Organisations: Section for Population- and Ecosystem Dynamics, National Institute of Aquatic Resources
Authors: Hüssy, K. (Intern), Tomkiewicz, J. (Intern)
Publication date: 1995
Main Research Area: Technical/natural sciences

Publication information
Journal: ICES CM 1995/
Volume: J:27
Original language: English
Source: orbit
Source-ID: 225862
Publication: Research › Conference article – Annual report year: 1995

Projects:

Capelin Migration and Stock Structure using Otolith Microchemistry

National Institute of Aquatic Resources
Period: 01/06/2017 → 31/05/2020
Number of participants: 3
Phd Student:
Fink-Jensen, Peter (Intern)
Supervisor:
Jansen, Teunis (Intern)
Main Supervisor:
Hüssy, Karin (Intern)

Financing sources
Source: Internal funding (public)
Assessing cod growth and age by otolith microchemistry analysis

National Institute of Aquatic Resources
Period: 01/10/2016 → 30/09/2019
Number of participants: 3
Phd Student:
Nielsen, Kristian Ege (Intern)
Supervisor:
Mosegaard, Henrik (Intern)
Main Supervisor:
Hüssy, Karin (Intern)

Financing sources
Source: Internal funding (public)

Sustainable management of Kattegat cod; Improved knowledge about stock components and migration (39346)
The Kattegat cod has been categorized as a data limited stock, mainly due to a large unallocated mortality, which may be caused by migration between Kattegat and neighbouring areas. In this project, we aim to improve our understanding of migration patterns and mixing of different stock components within the Kattegat through a novel combination of genetic and micro-chemical signatures for individual fish. Results from the project will feed directly into the ICES advisory process, including a scheduled benchmark meeting in early 2017 where new procedures for stock assessment will be discussed. As cod are also caught as bycatch in other fisheries, a more robust stock assessment for cod will also be important to fisheries for other species under the landing obligation, which is scheduled for implementation in the Kattegat in 2017.

This project is coordinated by DTU Aqua.

The project is funded by the Ministry of Environment and Food of Denmark and the European Maritime and Fisheries Fund (EMFF).

National Institute of Aquatic Resources
Section for Marine Living Resources
Danish Fishermen's Association

Tagging Baltic cod (TABACOD) (39333)
The aim of this project is to improve the management of eastern Baltic cod by 1) providing new information on growth and mortality patterns, and 2) develop a validated method for deriving this information from historic and future samples.

In recent years, the traditional age-based stock assessment had to be abandoned owing to extensive uncertainties in stock trends. These uncertainties were to a large extent attributable to inconsistencies in age estimation. As a consequence thereof, the current stock status is unknown.

Estimates of growth and mortality rely on unbiased age information. TABACOD will provide this information through a large scale tagging experiment, where 20,000 cod are tagged with and externally visible tag as well as with an internal tag on their otoliths. This experiment will also provide the samples for the development and validation of a new age estimation
method based on the chemical composition of the cod’s otoliths. The knowledge gained will be incorporated in length-based assessment models and their performance compared to the traditional methods evaluated in order to provide the ICES stock assessment group with the relevant tools to provide a reliable advice and to improve stock exploitation.

This project is coordinated by DTU Aqua.

The project is funded by BalticSea2020.

National Institute of Aquatic Resources
Section for Oceans and Arctic
Swedish University of Agricultural Sciences

Johann Heinrich von Thünen-Institute
National Marine Fisheries Research Institute

Period: 01/01/2016 → 31/12/2019
Number of participants: 7
Research areas: Marine Populations and Ecosystem Dynamics & Fish Biology & Marine Living Resources

Project participant:
Olesen, Hans Jakob (Intern)
Andersen, Niels Gerner (Intern)
Storr-Paulsen, Marie (Intern)
Thygesen, Uffe Høgsbro (Intern)
Berg, Casper Willestofte (Intern)

Phd Student:
Nielsen, Kristian Ege (Intern)

Project Coordinator:
Hüssy, Karin (Intern)

A systems approach framework for coastal research and management in the Baltic (BaltCoast) (39201)
The ultimate objective of this project is a coherent and systematic management approach that encompasses multiple impacts in a spatially heterogeneous context.

In BaltCoast we tackle this complex task using the Systems Approach Framework (SAF). The SAF is an issue oriented investigation and methodology that applies a holistic perspective. It investigates and quantifies the functions of systems in order to simulate specific questions concerning their functions or policies. It comprises the process from issue identification through system analyses to policy implementation.

This Systems Approach can, hence, competently address implementation of international directives (e.g. Water Framework Directive (WFD), Marine Strategy Framework Directive (MSFD)). In BaltCoast we address multiple issues through case studies that reflect current regional management challenges and develop a generic tool for integrated system assessment.

This project is coordinated by Leibniz-Institute for Baltic Sea Research (IOW).

The project is funded by EU, BONUS (Science for a Better Future of the Baltic Sea Region), ERA-NET.

National Institute of Aquatic Resources
Section for Ecosystem based Marine Management
Leibniz-Institute for Baltic Sea Research
Klaipeda University
Tallinn University
University of Latvia
Polish Academy of Sciences
Swedish University of Agricultural Sciences
Integrating spatial processes into ecosystem models for sustainable utilization of fish resources (INSPIRE) (39118)

The BONUS INSPIRE Project conducts pilot ecosystem field surveys that help resolving the habitat requirements of different life-stages of the focal species by combined use of traditional methods and application of modern advanced analysis and modelling techniques.

The research is conducted in a matrix approach with four species specific case (cod, herring, sprat and flounder) and five research work-packages. The work packages deal with (i) habitat requirements and survival probability for different life stages, (ii) connectivity between habitat occupied in successive life stages, (iii) spatial scaling from local events to regional population dynamics, (iv) spatially explicit analytical stock assessments (including a comprehensive flatfish programme), and (v) ecosystem-based management and Marine Strategy Framework Directive indicators.

The overarching questions of the BONUS INSPIRE Project are:
- What habitat (both pelagic and benthic) conditions characterize the spatial distributions of cod, herring, sprat and flounder?
- To what extent do fishing and species interaction affect the local and basin-scale distribution of exploited stocks?
- What drives spatial connectivity and migrations of different fish species/populations?
- How does stock structure and separation of natural populations impact stock assessment outcomes?

This project is coordinated by University of Tartu, Estonia.

The project is funded by EU, BONUS (Science for a Better Future of the Baltic Sea Region), ERA-NET.

National Institute of Aquatic Resources
Section for Oceans and Arctic
University of Tartu
National Marine Fisheries Research Institute
Stockholm University
Swedish University of Agricultural Sciences
Institute of Food Safety, Animal Health and Environment
Thünen Institut für Ostseefischerei
University of Hamburg
National Resources Institute Finland
GEOMAR - Helmholtz Centre for Ocean Research Kiel
Lund University
Uppsala University
Optimal sustainable use of cod stocks accessible for Danish fisheries (DEL-TORSK) (39147)

Optimal sustainable utilization of cod stocks that contain several biological sub-populations requires taking population structure into account in stock assessment and management. The aim of this project was to develop scientific basis for cod management decisions in the North Sea and the Baltic that takes biological units of cod and their dynamics into account.

Methodological challenges concerning advising on stocks that contain sub-populations with differences in dynamics and biological parameters are common for North Sea and the Baltic. Therefore, the project considered both seas, in terms of developing methodological basis for addressing population structure in management advice. The results were presented at ICES benchmarks for North Sea and Baltic Sea cod in 2015, and used to developing further the management basis for optimal use of cod stocks.

The project included mapping of distribution of sub-populations using genetic analyses and modelling of transport of early life stages. These results were combined with existing knowledge on cod population structure both in the Baltic and North Sea, to identify distribution areas of sub populations. This information was then incorporated in area-specific stock assessment analyses.

This project was coordinated by DTU Aqua.

The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).

National Institute of Aquatic Resources
Section for Ecosystem based Marine Management
Period: 17/07/2013 → 30/04/2015
Number of participants: 8
Research areas: Ecosystem based Marine Management & Marine Populations and Ecosystem Dynamics & Population Genetics & Fish Biology & Marine Living Resources & Fisheries Management
Project participant:
Hansen, Jakob Hemmer (Intern)
Mariani, Patrizio (Intern)
Berg, Casper Willestofte (Intern)
Hüssy, Karin (Intern)
Huwer, Bastian (Intern)
Nielsen, Anders (Intern)
Eg Nielsen, Einar (Intern)
Project Coordinator:
Eero, Margit (Intern)
Project

MSC certification of the plaice fishery in area IIIa – basic investigations and development of a management model (39025)

A management plan is an important requirement for MSC certification of specific fisheries. However, prior to this project, reliable stock assessments, which are necessary for a management plan for plaice (*Pleuronectes platessa*) in area IIIa (Kattegat/Skagerrak), had not been available. These problems most likely originated from insufficient knowledge about the geographical distribution of populations as well as the interactions between populations in Kattegat/Skagerrak and neighbouring areas. Through a mapping of the distribution and dynamics of populations, this project aimed at providing the missing data that would ultimately allow for the development of an management plan for the plaice fishery in area IIIa. The work included information from genetics, tagging, otolith based growth estimation, oceanographic modelling and analyses of survey and fisheries data.

Results from the project showed evidence of both local population components in the Kattegat/Skagerrak as well as substantial mixing between North Sea populations and these local components, and consequences of lumping or splitting the populations for stock assessment and management were discussed.

The outcomes of the work directly influenced the policy decisions since 2015. Decision was finally made to proceed with the lumping option, thus allowing a quantitative analytical assessment and management advice for the area. However, because of the differences in size between the two populations, there is a risk of depletion of the local Skagerrak population if the fisheries on it increase as a consequence of the increase in the North Sea stock. In terms of management, some mechanisms already exist for reducing the fishing pressure in the Skagerrak if deemed necessary, as plaice in the North Sea and in the Skagerrak are managed by two different Total Allowable Catches (TACs). It has therefore been suggested...
that routine monitoring of the survey and fisheries patterns would allow detecting any departures from the current situation, i.e. an ad coupling of trends in the different areas and the different seasons that could indicate a reduced productivity of the local stock.

In the longer-term, the current progresses on the biological knowledge of the stock in Skagerrak should be sustained. Additional genetic allocation of individual fish to the different populations should be performed to obtain a better quantification of the mixing in different areas and seasons, and the survey coverage should be improved in the Skagerrak. The project was coordinated by DTU Aqua.

The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).

National Institute of Aquatic Resources
Section for Marine Living Resources
Danish Fishermen's Association
Danish Fishermen's Producers' Organization
Period: 01/07/2012 → 31/12/2014
Number of participants: 9
Research areas: Population Genetics & Fisheries Management & Marine Living Resources
Project participant:
Christensen, Asbjørn (Intern)
Ulrich, Clara (Intern)
Boje, Jesper (Intern)
Hüssy, Karin (Intern)
Geitner, Kerstin (Intern)
Worsøe Clausen, Lotte (Intern)
Meldrup, Dorte (Intern)
Hansen, Frank Ivan (Intern)
Project Coordinator:
Hansen, Jakob Hemmer (Intern)
Project

The Mysterious Lumpfish (Cyclopterus lumpus) (38985)
The aim of the project is to exchange the knowledge of the lumpfish resources between the Nordic countries. There is no firm knowledge that can support a sustainable utilization of lumpfish e.g. lumpfish roe. We exchange data of the size and age distribution of the individual fish populations.

The project is coordinated by the Institute of Marine Research, Norway.

National Institute of Aquatic Resources
Public Sector Consultancy
Institute of Marine Research
Marine Research Institute
Greenland Institute of Natural Resources
Royal Greenland A/S
Period: 01/02/2012 → 31/12/2012
Number of participants: 2
Research area: Fisheries Management
Project participant:
Hüssy, Karin (Intern)
Project Manager, academic:
Larsen, Erling (Intern)
Project

Eastern-western Baltic cod: Improved management based on stock discrimination of eastern and western Baltic cod (Øst-Vesttorsk) (38989)
The aim of this project was to improve the management of western Baltic cod by incorporating stock identification routines in order to discriminate between eastern and western Baltic cod stocks.
In recent years evidence from fishery patterns and otolith structures have indicated an increasing degree of mixing between the two cod stocks which up until 2013 were managed as two separate stocks. Changes in fishing pressure and patterns would therefore result in a risk for local depletion of the smaller western stock. 

Stock identification methods were based on established approaches using genetic discrimination and otolith shape analysis, and improved by linking these methods. This method provides a tool to estimate the degree of stock mixing using the existing otolith archives. This approach documented an increase of eastern Baltic cod from 30% to > 80% in the eastern part of the western Baltic Sea management area. As a consequence of this stock mixing, a new procedure incorporating stock mixing on an annual basis was set in place with the aim to improve stock exploitation and reduce the risk of local depletion. The knowledge gained also influenced recent management regulations, particularly a prolongation of spawning closer of the fishery in 2016.

The project was coordinated by Centre for Environment, Fisheries & Aquaculture Science, UK. The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).

National Institute of Aquatic Resources
Section for Marine Ecology and Oceanography

Cefas
Period: 27/06/2011 → 29/03/2013
Number of participants: 18
Research areas: Marine Populations and Ecosystem Dynamics & Marine Living Resources & Population Genetics & Fisheries Management

Project participant:
Hansen, Jakob Hemmer (Intern)
Huwer, Bastian (Intern)
Bastardie, Francois (Intern)
Eero, Margit (Intern)
Nielsen, J. Rasmus (Intern)
Worsøe Clausen, Lotte (Intern)
Mosegaard, Henrik (Intern)
Storr-Paulsen, Marie (Intern)
Olesen, Hans Jakob (Intern)
Kirkegaard, Eskild (Intern)
Larsen, Peter Vingaard (Intern)
Hansen, Frank Ivan (Intern)
Lundgaard, Louise Scherffenberg (Intern)
Willandsen, Maj-Britt (Intern)
de Jong, Noortje (Intern)
Mensberg, Karen-Lise Dons (Intern)
Meldrup, Dorte (Intern)

Project Coordinator:
Hüssy, Karin (Intern)

Geographical distribution of fish resources and optimizing of fishery practice in the north-eastern North Sea (RESOURCE) (38878)
RESOURCES is a collaborative fishermen-scientist project in direct continuation of the REX projects in the north-eastern North Sea conducting small-scale scientific surveys, but only with one commercial trawler, encompassing also geographical distributional aspects as in OSKAR.

The REX project showed that changes in the biomass densities of cod differ between bottom types (and may depend on stock size) and the proportion of the cod population found on smooth bottoms is not constant. However, due to scaling problems and too short a time series the achieved results have so far had no impact on the assessment procedure or any (measurable) effect on the TAC’s (but the RAC discussions may have affected decisions by the European Commission). Continuation of the field work with the trawler in 2010–12 in the RESOURCE project should produce a sufficient time series for supplementing the abundance indices for the older ages in the assessment, which at present are based only on the catch rates in the international scientific surveys (IBTS). This total REX-RESOURCE time series will be used in the state space assessment of North Sea cod (SAM) and various other approaches applied to document how commercial CPUE may be used in the tuning procedure. Particular attention will be given to evaluate the size of the spawning stock of cod.
Mechanistic knowledge on vital rates together with REX, RESOURCE, OSKAR and IBTS (and possibly also UK) survey data will be used as input to the geostatistical tool GeoPop to estimate the temporal and spatial dynamics of the size distribution of the cod stock. This part of the project will represent a direct continuation of OSKAR principles including considerations to how to design an operational fishery-forecast system for North Sea cod.

The project is coordinated by DTU Aqua.

National Institute of Aquatic Resources

Section for Marine Ecology and Oceanography

Danish Fishermen's Association

Period: 01/01/2010 → 30/09/2012
Number of participants: 13
Research area: Marine Populations and Ecosystem Dynamics

Project participant:
Andersen, Niels Gerner (Intern)
Pedersen, Eva Maria (Intern)
Andersen, Bo Salgaard (Intern)
Hüsey, Karin (Intern)
Kristensen, Kasper (Intern)
Nielsen, Anders (Intern)
Stage, Bjarne (Intern)
Mosegaard, Henrik (Intern)
Christensen, Asbjørn (Intern)
Mariani, Patrizio (Intern)
Madsen, Niels (Intern)

Project Manager, academic:
Beyer, Jan (Intern)
Wieland, Kai (Intern)

Fehmarn Belt science provision project: Fehmarn Belt fish and fisheries and related environmental investigations (38669)

Objectives and Background
The purpose of the project was to investigate main exploited fish stock and fisheries dynamics in relation to the marine environment with focus on the Fehmarn Belt area in the Western Baltic Sea, and to provide science and research based investigations and results, as well as reports and scientific peer reviewed journal papers on this. The work was associated to the scientific baseline investigations (2009-13) and impact assessment of the projection of the Fehmarn Belt Fixed Link between Denmark and Germany involving a science cooperation between DTU Aqua, Thünen-Institute and Femern Bælt A/S in order to generate knowledge on potential impacts of establishment of the fixed link. Focus was on the most important commercial fisheries and fish stocks in the area (cod, herring, and sprat, but also flatfish and eels).

Tasks and Deliverables
The work covered WP0: Prospecting, planning and development of the investigations, producing outline and main contents of the science provision contract and coordination of tasks hereunder with DTU Aqua as inter-national project coordinator; WP1: Review of know-led-ge: Review, provision of data, and analyses of selected historical data on fish stock and fisheries dynamics; WP2: Extension of existing, standard research surveys and linking to standardsurvey time series to detect potential effects on important fish stocks; WP3: Evaluation of potential integrated effects on important fish stocks and fisheries; WP4: Evaluation of potential effects of change and variability in hydrographical features and conditions on recruitment for important fish stocks (cod, herring, sprat); WP5: Evaluation of herring occurrences and migrations as well as separation of spring and autumn spawning herring stock components in the area.

WP1 included provision of state of the art knowledge from historical surveys and review of quality of survey indices, commercial fisheries data, and information on recruitment dynamics with emphasis on fluctuations in distribution and productivity with respect to environmental and anthropogenic drivers of change including species interactions and fishing.

WP 2 included extension of existing standard surveys in the near field area and analyses of both the standard and extended time series with respect to variability in distribution, density and abundance patterns of relevant stocks, as well developing advanced scientific survey evaluation models and methods for this.

WP 3 analyzed stock and fisheries dynamics by use and development of complex multi-fleet-multi-stock bio-economic management evaluation models performing analyses on a very high spatial and temporal resolution scale using integrated fisheries, stock and survey data. The models evaluated different management options and scenarios relevant for the establishment of the fixed link.
WP4 evaluated variability in recruitment and important spawning areas according to hydrographic features and in relation to impact of the fixed link among other by use and further development of complex hydro-dynamic models. WP 5 evaluated herring stock occurrence and migration patterns in the Baltic areas by use of genetic identity markers, otolith micro-structures and information from fisheries and research surveys in order to evaluate impact of the fixed link. The project has besides a long row of project reports produced around 30 scientific peer reviewed journal papers where DTU Aqua are first author on more than half and co-author on more than 20 of the papers. The project was coordinated by DTU Aqua. The project was funded by the 3 partners with external Funding from Femern Bælt A/S.

National Institute of Aquatic Resources
Section for Ecosystem based Marine Management
Johann Heinrich von Thünen-Institute

Femern A/S
Period: 01/01/2009 → 31/12/2013
Number of participants: 15
Research areas: Fisheries Management & Fish Biology & Marine Living Resources & Population Genetics
Project participant:
Worsøe Clausen, Lotte (Intern)
Bastardie, Francois (Intern)
Bekkevold, Dorte (Intern)
Huwer, Bastian (Intern)
Hüssy, Karin (Intern)
Storr-Paulsen, Marie (Intern)
Stæhr, Karl-Johan (Intern)
Sparrevohn, Claus Reedtz (Intern)
Jepsen, Niels (Intern)
Lewy, Peter (Intern)
Kristensen, Kasper (Intern)
Dutz, Jörg (Intern)
Christensen, Asbjørn (Intern)
Geitner, Kerstin (Intern)
Project Coordinator:
Nielsen, J. Rasmus (Intern)

Individual based modelling of growth and survival of cod and sandeel larvae

National Institute of Aquatic Resources
Period: 15/12/2008 → 22/04/2013
Number of participants: 5
Phd Student:
Gürkan, Zeren (Intern)
Main Supervisor:
Mosegaard, Henrik (Intern)
Examiner:
Hüssy, Karin (Intern)
Gaard, Eilif (Ekstern)
Skogen, Morten Dahlberg (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU) Samf.
Project: PhD

Automated fish ageing (AFISA) (38111)
Most of European fish stocks are assessed using age-based models, the cost of the acquisition of age data from otolith readings raises several million euros annually. Low uncertainty in age estimation is however reached for only 25 % of fish stocks under ICES advising process. The impact of ageing errors on stock assessment is obvious though obscure. In this
context, automated ageing systems would provide a mean to standardize ageing among laboratories and to control ageing consistency while reducing the cost of the acquisition of age data. No such system is currently available, although preliminary results provide the basis for such developments.

This two-year project aims at developing fully automated and robust systems for routine ageing. It will comprise four work packages in addition to project management (WP0): the collation of the otolith material and the creation of bases of annotated otolith images (WP1), the development of algorithms for fish ageing automation from otolith features (WP2), the implementation these automated ageing modules in a software platform dedicated to otolith imaging (WP3), the cost-benefit analysis of the proposed automated ageing systems (WP4).

The whole processing chain from the acquisition of otolith data to the actual ageing issue using pattern recognition or statistical inference will be coped with. The demonstration component will include the demonstration of the degree of automation of the proposed systems and a cost-benefit analysis of these automated solutions for three case studies: cod from Faeroes, North Sea and North East Arctic, plaice from the Eastern English Channel (VII d) and Iceland, and anchovy from the Bay of Biscay. The focus will be on demonstrating the consistency of automated age estimation with respect to the major steps of the processing chain and to the joint analysis of ageing precision and acquisition costs with respect to stock assessment objectives.

The project is coordinated by Institut Francais de Recherche pour l'Exploitation de la Mer (IFREMER), France.

National Institute of Aquatic Resources
Section for Marine Ecology and Oceanography
IFREMER
Marine and Food Technological Centre
Cefas
Institute of Marine Research
Marine Research Institute
Polytechnic University of Catalonia
Period: 01/01/2007 → 31/12/2009
Number of participants: 5
Research areas: Marine Populations and Ecosystem Dynamics & Fish Biology
Project participant:
Christensen, Asbjørn (Intern)
Lewy, Peter (Intern)
Worsøe Clausen, Lotte (Intern)
Project Manager, academic:
Mosegaard, Henrik (Intern)
Hüssy, Karin (Intern)
Project

**Improved methodology for cod age estimation (DECOD3) (38120)**

The objective of this project is to develop and implement an objective method for the age-determination of Eastern Baltic cod. The assessment for Eastern Baltic Cod (Sub-divisions 25-32) has presented a number of problems in recent years. The key problem is the severe inconsistencies in age determination which affect both the catch-at-age and the survey data. The methods to be developed within this project are based on the use of otolith biometrics. This procedure has proven successful in other stocks with age-reading problems. The data series on commercial and survey catch length distributions, otolith biometrics and biological parameters (collected for ICES Study Group on Ageing Issues in Baltic Cod (SGABC)) will be extended back as far as 2000. Mixture and conditional models to estimate age structure for a given component in stock assessment will be developed as statistically robust approaches to age-determination. Based on this new method, the historic catch and survey data will be reconstructed. The primary focus is on data for routine single-species assessments, but data for multi-species assessments will also be updated where possible.

The project is coordinated by DTU Aqua.

National Institute of Aquatic Resources
Section for Marine Living Resources
Bundesforschungsanstalt für Fischerei
Swedish National Board of Fisheries
Baltic Sea management: Nature conservation and sustainable development of the ecosystem through spatial planning (BALANCE) (38432)

BALANCE aimed to develop transnational marine spatial planning tools and an agreed template for marine management planning and decision-making. It was based on four transnational pilot areas demonstrating the economical and environmental value of habitat maps and marine spatial planning (exemplified through two zoning plans). The tools and zoning plans integrated biological, geological and oceanographic data with local knowledge from stakeholders. A "blue corridor" concept was developed and promoted, i.e. between protected sites adding spatial development dimensions to the implementation of EU Directives. As a part of this work it was assessed if the Baltic marine Natura 2000 network is ecologically coherent and adequately represents and protects a continuum of habitats. A communication strategy was developed for stakeholder involvement to ensure that objectives and decisions address local stakeholders’ needs.

Spatial planning tools included Baltic Sea marine landscapes presented in GIS maps, a holistic approach to marine habitat mapping integrating data on benthic, pelagic and fish habitats in four transnational pilot areas, development of habitat models for areas with little biological information, templates for zoning plans in two pilot areas, including planning guidelines and criteria to evaluate management success, meta-database for Baltic Sea marine data, outlining data formats, techniques and data availability for use by stakeholders in future planning, development of agreed protocols for habitat mapping based on intercalibration of existing national protocols, ensuring compatible data for future transnational mapping.

DTU Aqua was mainly involved in habitat modelling (coastal and pelagic fish habitats) and in development of marine spatial planning and management frameworks.

In addition to DTU Aqua, 23 partners were involved in the BALANCE project, i.e. representing governmental and non-governmental organizations and research institutes from the entire Baltic region in the fields of biology/ecology, fisheries and geology.

The project was coordinated by DTU Aqua.

National Institute of Aquatic Resources

Section for Ecosystem based Marine Management

Period: 01/01/2005 → 31/12/2007
Number of participants: 8

Research area: Ecosystem Based Marine Management

Project participant:

Sørensen, Thomas Kirk (Intern)
Geitner, Kerstin (Intern)
Sparrevohn, Claus Reedtz (Intern)
Hüssy, Karin (Intern)
Köster, Fritz (Intern)
Tomkiewicz, Jonna (Intern)
Neuenfeldt, Stefan (Intern)

Project Manager, organisational:

Vestergaard, Ole (Ekstern)
Activities:

**ICES - Benchmark Workshop on Baltic Cod Stocks - WKBALTCOD (External organisation)**
Period: 2015
Karin Hüssy (Participant)
National Institute of Aquatic Resources
Section for Marine Ecology and Oceanography
Degree of recognition: International

Related external organisation

**ICES - Benchmark Workshop on Baltic Cod Stocks - WKBALTCOD**
Activity: Membership › Membership of committees, commissions, boards, councils, associations, organisations, or similar

**ICES - Herring Assessment Working Group for the Area South of 62ºN - HAWG (External organisation)**
Period: 2015
Karin Hüssy (Participant)
National Institute of Aquatic Resources
Section for Marine Ecology and Oceanography
Degree of recognition: International

Related external organisation

**ICES - Herring Assessment Working Group for the Area South of 62ºN - HAWG**
Activity: Membership › Membership of committees, commissions, boards, councils, associations, organisations, or similar

**ICES - The Workshop on Scoping for Integrated Baltic Cod Assessment - WKSIBCA (External organisation)**
Period: 2014
Karin Hüssy (Participant)
National Institute of Aquatic Resources
Section for Marine Ecology and Oceanography
Degree of recognition: International

Related external organisation

**ICES - The Workshop on Scoping for Integrated Baltic Cod Assessment - WKSIBCA**
Activity: Membership › Membership of committees, commissions, boards, councils, associations, organisations, or similar

**ICES - Working Group on Recruitment Forecasting in a Variable Environment - WGRFE (External organisation)**
Period: 2014
Karin Hüssy (Participant)
National Institute of Aquatic Resources
Section for Marine Ecology and Oceanography
Degree of recognition: International

Related external organisation

**ICES - Working Group on Recruitment Forecasting in a Variable Environment - WGRFE**
Activity: Membership › Membership of committees, commissions, boards, councils, associations, organisations, or similar

**ICES - Workshop on age validation studies of Gadoids - WKAVSG (External organisation)**
Period: 2013 → …
Karin Hüssy (Chairman)
National Institute of Aquatic Resources
Section for Marine Ecology and Oceanography
Degree of recognition: International

Related external organisation

ICES - Workshop on age validation studies of Gadoids - WKAVSG
Activity: Membership › Membership of committees, commissions, boards, councils, associations, organisations, or similar

ICES - Stock Identification Methods Working Group - SIMWG (External organisation)
Period: 2012 → …
Karin Hüssy (Participant)

National Institute of Aquatic Resources
Section for Population Ecology and Genetics
Degree of recognition: International

Related external organisation

ICES - Stock Identification Methods Working Group - SIMWG
Activity: Membership › Membership of committees, commissions, boards, councils, associations, organisations, or similar