A generic framework for individual-based modelling and physical-biological interaction

The increased availability of high-resolution ocean data globally has enabled more detailed analyses of physical-biological interactions and their consequences to the ecosystem. We present IBMlib, which is a versatile, portable and computationally effective framework for conducting Lagrangian simulations in the marine environment. The purpose of the framework is to handle complex individual-level biological models of organisms, combined with realistic 3D oceanographic model of physics and biogeochemistry describing the environment of the organisms without assumptions about spatial or temporal scales. The open-source framework features a minimal robust interface to facilitate the coupling between individual-level biological models and oceanographic models, and we provide application examples including forward/backward simulations, habitat connectivity calculations, assessing ocean conditions, comparison of physical circulation models, model ensemble runs and recently posterior Eulerian simulations using the IBMlib framework. We present the code design ideas behind the longevity of the code, our implementation experiences, as well as code performance benchmarking. The framework may contribute substantially to progresses in representing, understanding, predicting and eventually managing marine ecosystems.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Marine Living Resources, Section for Oceans and Arctic, Universidade de Aveiro
Authors: Christensen, A. (Intern), Mariani, P. (Intern), Payne, M. R. (Intern), Dias, J. M. (ed.) (Ekstern)
Pages: e0189956
Publication date: 2018
Main Research Area: Technical/natural sciences

Publication Information
Journal: P L o S One
Volume: 13
Issue number: 1
ISSN (Print): 1932-6203
Ratings:
BFI (2018): BFI-level 1
Integrated ecological-economic fisheries models - evaluation, review and challenges for implementation

Marine ecosystems evolve under many interconnected and area-specific pressures. In order to fulfill society's intensifying and diversifying needs whilst ensuring ecologically sustainable development, more effective marine spatial planning and broader-scope management of marine resources is necessary. Integrated ecological–socioeconomic fisheries models (IESFM) of marine systems are needed to evaluate impacts and sustainability of potential management actions and understand, and anticipate ecological, economic, and social dynamics at a range of scales from local to national and regional. To make these models most effective, it is important to determine how model characteristics and methods of communicating results influence the model implementation, the nature of the advice that can be provided and the impact on decisions taken by managers. This paper presents a global review and comparative evaluation of 35 IESFM's applied to marine fisheries and marine ecosystem resources to identify the characteristics that determine their usefulness, effectiveness and implementation. The focus is on fully integrated models that allow for feedbacks between ecological and human processes though not all the models reviewed achieve that
**Analysis of marine protected areas – in the Danish part of the North Sea and the Central Baltic around Bornholm: Part 2: Ecological and economic value, human pressures, and MPA selection**

**General information**

State: Published  
Organisations: National Institute of Aquatic Resources, Section for Oceans and Arctic, Section for Ecosystem based Management, Section for Marine Living Resources, Section for Monitoring and Data, DHI Denmark, Geological Survey of Denmark and Greenland, Aarhus University, University of Copenhagen  
Number of pages: 120  
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Publisher: National Institute of Aquatic Resources, Technical University of Denmark  
ISBN (Electronic): 978-87-7481-245-6  
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http://www.aqua.dtu.dk/Publikationer/Forskningsrapporter/Forskningsrapporter_siden_2008  
Publication: Research › Report – Annual report year: 2018

**Dynamiske brugerstyrede havkort til værdiløft af dansk industrifiskeri (GUDP-VIND)**

**General information**

State: Published  
Organisations: National Institute of Aquatic Resources, Section for Marine Living Resources, Section for Marine Ecology and Oceanography, AnchorLab, Danish Meteorological Institute, Danish Fishermen’s Producers’ Organization  
Authors: Mosegaard, H. (Intern), Pedersen, E. M. (Intern), Sparrevohn, C. R. (Ekstern), Lund, H. S. (Ekstern), Skov, O. (Ekstern), Dueholm, M. (Ekstern), She, J. (Ekstern), Christensen, A. (Intern), Stage, B. (Intern), Worsøe Clausen, L. (Intern), Deurs, M. V. (Intern), Bekkevold, D. (Intern), Andersen, N. G. (Intern)  
Publication date: 2017  
Event: Abstract from Dansk Havforskermøde, Helsingør, Denmark.  
Main Research Area: Technical/natural sciences  
Publication: Research › Conference abstract for conference – Annual report year: 2017

**Productivity and recovery of forage fish under climate change and fishing: North Sea sandeel as a case study**

Forage fish occupy a central position in marine foodwebs worldwide by mediating the transfer of energy and organic matter from lower to higher trophic levels. The lesser sandeel (Ammodites marinus) is one of the ecologically and economically most important forage fish species in the North-east Atlantic, acting as a key prey for predatory fish and sea birds, as well as supporting a large commercial fishery. In this case study, we investigate the underlying factors affecting recruitment and how these in turn affect productivity of the North Sea sandeel using long-term data and modelling. Our results demonstrate how sandeel productivity in the central North Sea (Dogger Bank) depends on a combination of external and internal regulatory factors, including fishing and climate effects, as well as density dependence and food availability of the preferred zooplankton prey (Calanus finmarchicus and Temora longicornis). Furthermore, our model scenarios suggest that while fishing largely contributed to the abrupt stock decline during the late 1990s and the following period of low biomass, a complete recovery of the stock to the highly productive levels of the early 1980s would only be possible through changes in the surrounding ecosystem, involving lower temperatures and improved feeding conditions. To that end, we stress the need for ecosystem-based management accounting for multiple internal and external factors occurring within the broader context of the ecosystem in which forage fish species, such as sandeel, play an important and integral part

**General information**

State: Accepted/In press  
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Section for Marine Living Resources, Section for Oceans and Arctic, Section for Ecosystem based Marine Management, International Council for the Exploration of the Sea
Ballastvand – Værktøj til afgrænsning af "Same Risk Area"

General information
State: Published
Organisations: National Institute of Aquatic Resources, Arctic Section, Section for Marine Living Resources
Patterns and mechanisms of dispersal in a keystone seagrass species

Z. noltei shows low genetic connectivity (from 10 s to 100 s of km) in the Black Sea. Physical modelling of dispersal well agree with estimates of genetic connectivity. Physical and genetic connectivity show possible but rare long distance dispersal. Seeds get dispersed locally while shoots have higher dispersal potential. Physical and genetic measures estimate potential and realized connectivity.

General information
State: Published
Authors: Jahnke, M. (Ekstern), Christensen, A. (Intern), Micu, D. (Ekstern), Milchakova, N. (Ekstern), Sezgin, M. (Ekstern), Todorova, V. (Ekstern), Strungaru, S. (Ekstern), Procaccini, G. (Ekstern)
Pages: 54-62
Publication date: 2016
Main Research Area: Technical/natural sciences

Publication information
Journal: Marine Environmental Research
Same-Risk-Area Assessment Model (SRAAM) User’s manual

General information

State: Published
Organisations: National Institute of Aquatic Resources, Arctic Section, Section for Marine Living Resources
Authors: Hansen, F. T. (Intern), Christensen, A. (Intern)
Variability and connectivity of plaice populations from the Eastern North Sea to the Baltic Sea, part II. Biological evidence of population mixing

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 coast line 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.
We present an integrated end-to-end modeling framework that enables whole-of ecosystem climate, eutrophication, and spatial scenario exploration in the Baltic Sea. The framework is built around the Baltic implementation of the spatially-explicit end-to-end ATLANTIS model, linked to the high-resolution coupled physical-biological model HBM-ERGOM and the fisheries bio-economic FishRent model. We investigate ecosystem-wide responses to changes in human-induced pressures by simulating several eutrophication scenarios that are relevant to existing Baltic Sea management plans (e.g. EU BSAP, EU CFP). We further present the structure and calibration of the Baltic ATLANTIS model and the operational linkage to the other models. Using the results of eutrophication scenarios, and focusing on the relative changes in fish and fishery production, we discuss the robustness of the model linking with respect to the underlying assumptions, strengths and weaknesses of individual models. Furthermore, we describe how to possibly expand the framework to account for spatial impacts and economic consequences, for instance by linking to the individual-vessel based DISPLACE modeling approach. We conclude that the proposed model integration and management
scenario evaluation scheme lays the foundations for developing a robust framework for management strategy evaluation that is of strategic importance to stakeholders from around the Baltic Sea.

**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, Section for Monitoring and Data, Technical University of Denmark, Aarhus University, University of Southern Denmark, CSIRO Ocean and Atmospheres, University of Copenhagen
Authors: Palacz, A. (Intern), Nielsen, J. R. (Intern), Christensen, A. (Intern), Hoff, A. (Ekstern), Frost, H. (Ekstern), Gislason, H. (Intern), Maer, M. (Ekstern), Bastardie, F. (Intern), Gaitner, K. (Intern), Hasler, B. (Ekstern), Ravn-Jonsen, L. (Ekstern), Hutniczak, B. (Forskerdatabase), Fulton, E. A. (Ekstern)
Number of pages: 2
Publication date: 2015
Event: Abstract from ICES Annual Science Conference 2015, Copenhagen, Denmark.
Main Research Area: Technical/natural sciences
Additional files:

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ICES CM 2015/M:12
Publication: Research › Conference abstract for conference – Annual report year: 2015

**Biogeographic changes in fish diversity driven by changes in climate and exploitation**

**General information**
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Section for Marine Living Resources, Section for Marine Ecology and Oceanography, University of Copenhagen
Authors: Bryndum, K. M. (Intern), Christensen, A. (Intern), She, J. (Ekstern), Richardson, K. (Ekstern), MacKenzie, B. (Intern)
Number of pages: 2
Publication date: 2015
Event: Abstract from ICES Annual Science Conference 2015, Copenhagen, Denmark.
Main Research Area: Technical/natural sciences
Electronic versions:

**Bibliographical note**
ICES CM 2015/Q:04
Publication: Research › Conference abstract for conference – Annual report year: 2015

**Connectivity, growth and survival in a spatially structured fish population, which is currently managed as seven separate stock units**

**General information**
State: Published
Organisations: National Institute of Aquatic Resources, Section for Marine Living Resources, Section for Marine Ecology and Oceanography
Authors: Nielsen, K. E. (Intern), Azour, F. (Intern), Bekkevold, D. (Intern), Christensen, A. (Intern), Hüssy, K. (Intern), Lundgaard, L. S. (Intern), Mosegaard, H. (Intern), Møller, P. R. (Ekstern), Deurs, M. V. (Intern)
Publication date: 2015
Event: Main Research Area: Technical/natural sciences
Electronic versions:

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ICES C.M. 2015/A:36
Publication: Research › Poster – Annual report year: 2015

**Estimering af zooplankton dødelighed i en 3D økosystemmodel ved at anvende en rumlig- og tidlig varierende fiskeprædation**
Impacts of the local environment on recruitment – a comparative study of North Sea and Baltic Sea fish stocks

While the impact of environmental forcing on recruitment variability in marine populations remains largely elusive, studies spanning large spatial areas and many stocks are able to identify patterns common to different regions and species. In this study, we investigate the effects of the environment on the residuals of a Ricker stock-recruitment (SR) model, used as a proxy of prerecruits’ survival, of 18 assessed stocks in the Baltic and North Seas. A probabilistic principal components (PCs) analysis permits the identification of groups of stocks with shared variability in the prerecruits’ survival, most notably a group of pelagics in the Baltic Sea and a group composed of gadoids and herring in the North Sea. The first two PCs generally grouped the stocks according to their localizations: the North Sea, the Kattegat-Western Baltic, and the Baltic Sea. This suggests the importance of the local environmental variability on the recruitment strength. Hence, the prerecruits’ survival variability is studied according to geographically disaggregated and potentially impacting abiotic or biotic variables. Time series (1990-2009) of nine environmental variables consistent with the spawning locations and season for each stock were extracted from a physical-biogeochemical model to evaluate their ability to explain the survival of prerecruits. Environmental variables explained >70% of the survival variability for eight stocks. The variables water current, salinity, temperature, and biomass of other fish stocks are regularly significant in the models. This study shows the importance of the local environment on the dynamics of SR. The results provide evidence of the necessity of including environmental variables in stock assessment for a realistic and efficient management of fisheries.
Korttidsprognoser 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), Hüssy, 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
**Larval grazing on zooplankton from a spatial model of the North Sea larval community**

**General information**

State: Published
Organisations: National Institute of Aquatic Resources, Section for Marine Living Resources, Section for Ecosystem based Marine Management, Aarhus University, Danish Meteorological Institute
Authors: Christensen, A. (Intern), Maar, M. (Ekstern), Rindorf, A. (Intern), Møller, E. F. (Ekstern), Madsen, K. S. (Ekstern), Deurs, M. V. (Intern)
Publication date: 2015
Event: Abstract from 18. Danske Havforskermøde, Copenhagen, Denmark.
Main Research Area: Technical/natural sciences

**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), Hüussy, K. (Intern), Worsøe Clausen, L. (Intern)
Number of pages: 52
Publication date: 2015

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Original language: English

Series: DTU Aqua Report
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**Predicting future shifts in herring spawning habitat in the North Sea**

**General information**

State: Published
Organisations: National Institute of Aquatic Resources, Section for Marine Living Resources, Section for Marine Ecology and Oceanography, Danish Meteorological Institute
Authors: Tsoukali, S. (Intern), Christensen, A. (Intern), Tian, T. (Ekstern), Visser, A. (Intern), MacKenzie, B. (Intern)
Number of pages: 2
Publication date: 2015
Event: Abstract from ICES Annual Science Conference 2015, Copenhagen, Denmark.
Main Research Area: Technical/natural sciences
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**Electronic versions:**

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<tr>
<td>Publishers_version</td>
<td>Research › Conference abstract for conference – Annual report year: 2015</td>
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**The Baltic ATLANTIS model: Implementing a holistic framework to evaluate ecosystem wide responses to changes in climate and anthropogenic forcing**

**General information**
The use of at-sea-sampling data to dissociate environmental variability in Norway lobster (Nephrops norvegicus) catches to improve resource exploitation efficiency within the Skagerrak/Kattegat trawl fishery

Research into the influence of environmental variables on the behaviour of Norway lobster (Nephrops norvegicus), and hence catch rates, dates back to the 1960s (e.g., Höglund and Dybern, Diurnal and seasonal variations in the catch-composition of Nephrops norvegicus (L.) at the Swedish west coast. ICES CM 1965/I46; Simpson, Variations in the catches of Nephrops norvegicus at different times of day and night. Rapport et Proès-verbaux des Réunions Conseil permanent international pour l'Exploration de la Mer 156:186). However, the use of fishery-dependent data in identifying influential factors is relatively limited and only includes a number of papers on a limited dataset (e.g., Redant and De Clark, Diurnal variations in CPUE and length composition of the catches in a Nephrops directed fishery in the Central North Sea. ICES CM 1984/K:3; Maynou and Sardà, Influence of environmental factors on commercial trawl catches of Nephrops norvegicus (L.). ICES J. Mar. Sci. 58:1318). Here, we aimed to dissociate environmental variability in Norway lobster catches to improve resource exploitation efficiency within the Skagerrak and Kattegat trawl fisheries by utilising data collected as part of an extensive at-sea-sampling programme spanning 16 years. Catch rates were modelled using Generalized Additive Mixed Models (GAMMs) and considered a range of response variables, including depth, temperature, current speed, season, moon phase and time of day. The results obtained herein showed that time of day, season, depth, temperature, year, trawl type and location all significantly affect catch rates of Nephrops.
Route optimisation and solving Zermelo's navigation problem during long distance migration in cross flows

The optimum path to follow when subjected to cross flows was first considered over 80 years ago by the German mathematician Ernst Zermelo, in the context of a boat being displaced by ocean currents, and has become known as the ‘Zermelo navigation problem’. However, the ability of migrating animals to solve this problem has received limited consideration, even though wind and ocean currents cause the lateral displacement of flyers and swimmers, respectively, particularly during long-distance journeys of 1000s of kilometres. Here, we examine this problem by combining long-distance, open-ocean marine turtle movements (obtained via long-term GPS tracking of sea turtles moving 1000s of km), with a high resolution basin-wide physical ocean model to estimate ocean currents. We provide a robust mathematical framework to demonstrate that, while turtles eventually arrive at their target site, they do not follow the optimum (Zermelo’s) route. Even though adult marine turtles regularly complete incredible long-distance migrations, these vertebrates primarily rely on course corrections when entering neritic waters during the final stages of migration. Our work introduces a new perspective in the analysis of wildlife tracking datasets, with different animal groups potentially exhibiting different levels of complexity in goal attainment during migration.
The Baltic ATLANTIS model: Implementing a holistic framework to evaluate ecosystem wide responses to changes in climate and anthropogenic forcing

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, Section for Monitoring and Data, Centre for Ocean Life, Aarhus University
Authors: Palacz, A. (Intern), Nielsen, J. R. (Intern), Christensen, A. (Intern), Gislason, H. (Intern), Bastardie, F. (Intern), Geitner, K. (Intern), Maar, M. (Ekstern), Lindegren, M. (Intern), Hufnagl, M. (Intern), Fulton, E. (Ekstern)
Number of pages: 1
Publication date: 2014
Event: Poster session presented at EU-FP7-VECTORS Symposium, La Grande Motte, France.
Main Research Area: Technical/natural sciences
Publication: Research › Poster – Annual report year: 2014

The use of at-sea-sampling data to dissociate environmental variability in Norway lobster (Nephrops norvegicus) catches to improve resource efficiency

The primary aim of this study was to determine whether the information collected as part of the at-sea-sampling program could be used to identify hydrographical and environmental variables that are influential on catch rates of Norway lobster. Ultimately, we wanted to know whether environmental variables' influence on catches could be accounted for in order to improve resource efficiency and economic viability

General information
State: Published
Zooplankton mortality in 3D ecosystem modelling considering variable spatial–temporal fish consumptions in the North Sea

We tested the feasibility of imposing mesozooplankton mortality into a 3D model based on estimated consumption rates of the dominant planktivorous fish in the North Sea-Kattegat area. The spatial biomass distribution of Atlantic herring (Clupea harengus), horse mackerel (Trachurus trachurus), Atlantic mackerel (Scomber scombrus), sandeel (Ammodytidae) and European sprat (Sprattus sprattus) was derived from quarterly scientific trawl surveys and Danish commercial catches. Spatio-temporal indices of mortality were created based on the estimated biomasses and ingestion rates from the literature. The fish larvae grazing pressure was obtained from a spatial, size-based larval community model. In this model, larvae, herring and sandeel were the most important fish predators on mesozooplankton, but these groups had different spatial and temporal (seasonal) distributions. Fish larvae were particularly dominant in the eastern and southern areas in early summer. Herring and sandeel had the highest consumption in the central and north-western areas and were more important in late summer. The fish index changed the perceived annual, seasonal and spatial patterns in modelled mesozooplankton biomass, production and mortality. In the present study, the index was kept relatively simple and can be further developed with respect to the description of fish as well carnivorous zooplankton ingestion rates. The data input required to create the fish index is i) planktivorous fish stock biomasses and ii) relative fish spawning distribution information and iii) physics (ocean currents and temperatures) for the region and situation of interest. The fish index seems promising as a realistic mortality term for lower trophic levels in 3D ecosystem models in areas with available data on fish stocks to improve management of marine resources
Fish benefits from offshore wind farm development

The studies up until 2006 showed few effects on the fish fauna that could be attributed to the establishment and operation of the wind farms. Fish abundance and diversity were not higher inside the wind farms than in the areas outside the wind farms. One obvious reason for this could be that the studies and investigations were made during the early stages of colonisation of the turbine foundations at Horns Rev that constitute artificial reefs. At Nysted, the effect was weak, presumably because the benthic community consisted of a monoculture of large common mussels (Mytilus edulis) that are only moderately attractive to fish.

Also investigations into the effects on fish and fish behaviour from electromagnetic fields were made at Nysted. Data documented some effects from the cable route on fish behaviour, with some species avoiding the cable, while other species were attracted. However, only flounder (Platichthys flesus) showed correlation between the phenomena observed and the strength of the magnetic fields.

General information

State: Published
Organisations: National Institute of Aquatic Resources, Section for Coastal Ecology, Section for Population Ecology and Genetics, Orbicon
Authors: Leonhard, S. B. (Ekstern), Stenberg, C. (Intern), Støttrup, J. (Intern), Deurs, M. V. (Intern), Christensen, A. (Intern), Pedersen, J. (Ekstern)
Pages: 31-45
Publication date: 2013

Host publication Information

Title of host publication: Danish offshore wind - key environmental issues – a follow-up
Modelling the economic consequences of Marine Protected Areas using the BEMCOM model

This paper introduces and describes in detail the bioeconomic optimization model BEMCOM (BioEconomic Model to evaluate the Consequences of Marine protected areas) that has been developed to assess the economic effects of introducing Marine Protected Areas (MPA) for fisheries. BEMCOM answers the question ‘what’s best?’; i.e. finds the overall optimal effort allocation, from an economic point of view, between multiple harvesting fleets fishing under a subset of restrictions on catches and effort levels. The BEMCOM model is described and applied to the case of the Danish sandeel fishery in the North Sea. It has several times been suggested to close parts of the sandeel fishery in the North Sea out of concern for other species feeding on sandeel and/or spawning in the sandeel habitats. The economic effects of such closures have been assessed using BEMCOM. The results indicate that the model yields reliable estimates of the effect of MPAs, and can thus be a valuable tool when deciding where to locate MPA

General information
State: Published
Organisations: Section for Population Ecology and Genetics, National Institute of Aquatic Resources
Authors: Hoff, A. (Ekstern), Andersen, J. (Ekstern), Christensen, A. (Intern), Mosegaard, H. (Intern)
Pages: 305-323
Publication date: 2013
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Bioeconomics
Volume: 15
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ISSN (Print): 1387-6996
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Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.591 SNIP 0.548 CiteScore 0.9
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.457 SNIP 0.964 CiteScore 0.71
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.241 SNIP 0.317 CiteScore 0.52
BFI (2013): BFI-level 1
Sandeel display strong site-fidelity, and spend most of their life buried in the seabed. This strategy carries important ecological implications. Sandeels save energy when they are not foraging but in return are unable to move substantially and therefore possibly are sensitive to local depletion of prey. Here we studied zooplankton consumption and energy conversion efficiency of lesser sandeel (Ammodytes marinus) in the central North Sea, using stomach data, length and weight-at-age data, bioenergetics, and hydrodynamic modeling. The results suggested: (i) Lesser sandeel in the Dogger area depend largely on relatively large copepods in early spring. (ii) Lesser sandeel is an efficient converter making secondary production into fish tissue available for higher trophic levels. Hence, changes in species composition towards a more herring dominated system, as seen in recent times, may lead to a decrease in system transfer efficiency. (iii) Sandeels leave footprints in the standing copepod biomass as far as 100 km from the edge of their habitat, but smaller and more isolated sandeel habitat patches have a much lower impact than larger patches, suggesting that smaller habitats can sustain higher sandeel densities and growth rates per area than larger habitats.
Plankton grazing and high energy conversion efficiency – Ecological implications of sandeel behavior and strategy MEPS 2013

DOIs: 10.3354/meps10390

Relations
Projects:
Patchy zooplankton grazing and high energy conversion efficiency: ecological implications of sandeel behavior and strategy

Publication: Research - peer-review › Journal article – Annual report year: 2013

Spatio-temporal dynamics of growth and survival of Lesser Sandeel early life-stages in the North Sea: Predictions from a coupled individual-based and hydrodynamic-biogeochemical model

Accounting for the individual variability and regional variations are important when predicting recruitment in fish species. Spatially explicit descriptions for recruitment in sandeels are necessary and sandeel growth and survival depend locally on...
zooplankton prey. We investigate the responses of larval and early juvenile Lesser Sandeel (Ammodytes marinus) in the North Sea to local feeding conditions by an adapted version of a generic bioenergetic individual-based model for larval fish describing growth and survival. Prey encounter and physiological processes are described explicitly in the model, which allows analyzing the influence of prey on the growth and survival of sandeel. The model is coupled to a hydrodynamic-biogeochemical model with physical and prey fields and implemented in temporal and three-dimensional spatial settings. Zooplankton biomass simulated by the biogeochemical model is validated by Continuous Plankton Recorder survey time series data. Spatio-temporal dynamics of the sandeel cohorts are simulated by the integrated model framework for the period 2004-2006 and five major area divisions of suitable sandeel habitats in the North Sea. This allows obtaining insight into the influence of temperature variation and zooplankton availability on the growth and survival. To determine areas promising for recruitment, area divisions are compared and optimal time of hatching for higher survival to recruitment due to match-mismatch with prey is determined by comparing different hatching times. The effect of vertical diel migration behavior of sandeel on the model outcomes is also examined. Vertical migration of sandeel results in increased feeding ability and growth and decreased starvation mortality of individuals. Results show that areas of German Bight and Southern Bight with high zooplankton production support high growth of sandeel. Most sandeel survive to settling in the Dogger Bank area that has large retention on average and still productive in zooplankton. Hatching at the optimal time of March/February with matching zooplankton peak concentrations enhances the growth and survival. Growth correlates positively with the observed temperature trend. Survival correlates negatively with temperature and prominently, when the hatching is in winter. © 2012 Elsevier B.V.

General information
State: Published
Organisations: Section for Population Ecology and Genetics, National Institute of Aquatic Resources, Section for Ocean Ecology and Climate, Aarhus University, Danish Meteorological Institute
Authors: Gurkan, Z. (Intern), Christensen, A. (Intern), Maar, M. (Forskerdatabase), Møller, E. F. (Forskerdatabase), Madsen, K. S. (Forskerdatabase), Munk, P. (Intern), Mosegaard, H. (Intern)
Pages: 294-306
Publication date: 2013
Main Research Area: Technical/natural sciences

Publication information
Journal: Ecological Modelling
Volume: 250
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Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 2.43 SJR 0.941 SNIP 1.089
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.087 SNIP 1.112 CiteScore 2.43
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.135 SNIP 1.353 CiteScore 2.7
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.153 SNIP 1.329 CiteScore 2.53
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.029 SNIP 1.229 CiteScore 2.28
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.183 SNIP 1.134 CiteScore 2.34
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Towards an integrated forecasting system for fisheries on habitat-bound stocks

First results of a coupled modelling and forecasting system for fisheries on habitat-bound stocks are being presented. The system consists currently of three mathematically, fundamentally different model subsystems coupled offline: POLCOMS providing the physical environment implemented in the domain of the north-west European shelf, the SPAM model which describes sandeel stocks in the North Sea, and the third component, the SLAM model, which connects POLCOMS and SPAM by computing the physical–biological interaction. Our major experience by the coupling model subsystems is that well-defined and generic model interfaces are very important for a successful and extendable coupled model framework. The integrated approach, simulating ecosystem dynamics from physics to fish, allows for analysis of the pathways in the ecosystem to investigate the propagation of changes in the ocean climate and to quantify the impacts on the higher trophic level, in this case the sandeel population, demonstrated here on the basis of hindcast data. The coupled forecasting system is tested for some typical scientific questions appearing in spatial fish stock management and marine spatial planning, including determination of local and basin-scale maximum sustainable yield, stock connectivity and source/sink structure. Our presented simulations indicate that sandeel stocks are currently exploited close to the maximum sustainable yield, even though periodic overfishing seems to have occurred, but large uncertainty is associated with determining stock maximum sustainable yield due to stock inherent dynamics and climatic variability. Our statistical ensemble simulations indicates that the predictive horizon set by climate interannual variability is 2–6 yr, after which only an asymptotic probability distribution of stock properties, like biomass, are predictable.

General information

State: Published
Organisations: National Institute of Aquatic Resources, Section for Marine Living Resources, Plymouth Marine Laboratory
Authors: Christensen, A. (Intern), Butenschön, M. (Ekstern), Gürkan, Z. (Intern), Allen, I. J. (Ekstern)
Pages: 261-279
Publication date: 2013
Main Research Area: Technical/natural sciences
Growth and survival of larval and early juvenile lesser sandeel in patchy prey field in the North Sea: An examination using individual-based modelling

Disentangling physical–biological interaction processes during early life-stages of fish is crucial for the understanding of fish stock recruitment. Among many individual and environmental aspects affecting mortality during the early life-stages of fish, encountering food at greater than average concentrations is regarded important for survival. Intense aggregations of zooplankton in near-surface waters provide these conditions for larval fish. Simulation studies by individual-based modeling can help understanding of the mechanisms for survival during early life-stages. In this study, we examined how growth and survival of larvae and early juveniles of Lesser Sandeel (Ammodytes marinus) in the North Sea are influenced by availability and patchiness of the planktonic prey by adapting and applying a generic bioenergetic individual-based model for larval fish. Input food conditions were generated by modeling copepod size spectra dynamics and patchiness based on particle count transects and Continuous Plankton Recorder time series data. The study analyzes the effects of larval hatching time, presence of zooplankton patchiness and within patch abundance on growth and survival of sandeel.
early life-stages in the North Sea. Simulations of patchiness related starvation mortality are able to explain observed patterns of variation in sandeel growth. Reduced prey densities within patches decrease growth and survival rate of larvae and match–mismatch affect growth and survival of larvae with different hatch time due to plankton seasonality. Of general scientific and environmental management interest, the results indicate a steep threshold concentration critical for survival at around 0.04–0.05 no. zooplankton/mL.

General information
State: Published
Organisations: Section for Population Ecology and Genetics, National Institute of Aquatic Resources
Authors: Gürkan, Z. (Intern), Christensen, A. (Intern), Deurs, M. V. (Intern), Mosegaard, H. (Intern)
Pages: 78-90
Publication date: 2012
Main Research Area: Technical/natural sciences

Publication information
Journal: Ecological Modelling
Volume: 232
ISSN (Print): 0304-3800
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 2.43 SJR 0.941 SNIP 1.089
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.087 SNIP 1.112 CiteScore 2.43
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.135 SNIP 1.353 CiteScore 2.7
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.153 SNIP 1.329 CiteScore 2.53
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.029 SNIP 1.229 CiteScore 2.28
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.183 SNIP 1.134 CiteScore 2.34
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.077 SNIP 1.132
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.294 SNIP 1.26
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.335 SNIP 1.312
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.335 SNIP 1.363
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.223 SNIP 1.548
Web of Science (2006): Indexed yes
Towards an integrated forecasting system for pelagic fisheries

First results of a coupled modelling and forecasting system for pelagic fisheries are presented. The system consists of three mathematically fundamentally different model subsystems: POLCOMSERSEM provides the physical–biogeochemical environment in the northwest European shelf, the Sandeel Population Analysis Model describes sandeel stocks in the North Sea, and the Sandeel Larval Analysis Model connects POLCOMS-ERSEM and SPAM by computing the physical–biological interaction. Our main findings by coupling model subsystems is that well-defined and generic model interfaces are very important for a successful and extendable coupled model framework. The integrated approach, simulating ecosystem dynamics from physics to fish, allows analysis of the pathways in the ecosystem to investigate the propagation of changes in the ocean climate and lower trophic levels to quantify the impacts on the higher trophic level, in this case the sandeel population, demonstrated here on the basis of hindcast data. The coupled forecasting system has been tested for some typical scientific questions appearing in spatial fish stock management and marine spatial planning, including determination of local-and basin-scale maximum sustainable yield, stock connectivity, and source/sink structure. Our presented simulations indicate that sandeel stocks are currently exploited close to the maximum sustainable yield, but large uncertainty is associated with determining stock maximum sustainable yield due to stock eigendynamics and climatic variability. Our statistical ensemble simulations indicate that the predictive horizon set by climate interannual variability is 2–6 years, after which only an asymptotic probability distribution of stock properties, such as biomass, is predictable.
Towards an integrated forecasting system for pelagic fisheries

First results of a coupled modelling and forecasting system for pelagic fisheries are presented. The system consists of three mathematically fundamentally different model subsystems: POLCOMSERSEM provides the physical–biogeochemical environment in the northwest European shelf, the Sandeel Population Analysis Model describes sandeel stocks in the North Sea, and the Sandeel Larval Analysis Model connects POLCOMS-ERSEM and SPAM by computing the physical–biological interaction. Our main findings by coupling model subsystems is that well-defined and generic model interfaces are very important for a successful and extendable coupled model framework. The integrated approach, simulating ecosystem dynamics from physics to fish, allows analysis of the pathways in the ecosystem to investigate the propagation of changes in the ocean climate and lower trophic levels to quantify the impacts on the higher trophic level, in this case the sandeel population, demonstrated here on the basis of hindcast data. The coupled forecasting system has been tested for some typical scientific questions appearing in spatial fish stock management and marine spatial planning, including determination of local- and basin-scale maximum sustainable yield, stock connectivity, and source/sink structure. Our presented simulations indicate that sandeel stocks are currently exploited close to the maximum sustainable yield, but large uncertainty is associated with determining stock maximum sustainable yield due to stock eigendynamics and climatic variability. Our statistical ensemble simulations indicate that the predictive horizon set by climate interannual variability is 2–6 years, after which only an asymptotic probability distribution of stock properties, such as biomass, is predictable.
analysis of the pathways in the ecosystem to investigate the propagation of changes in the ocean climate and lower trophic levels to quantify the impacts on the higher trophic level, in this case the sandeel population, demonstrated here on the basis of hindcast data. The coupled forecasting system has been tested for some typical scientific questions appearing in spatial fish stock management and marine spatial planning, including determination of local-and basin-scale maximum sustainable yield, stock connectivity, and source/sink structure. Our presented simulations indicate that sandeel stocks are currently exploited close to the maximum sustainable yield, but large uncertainty is associated with determining stock maximum sustainable yield due to stock eigendynamics and climatic variability. Our statistical ensemble simulations indicate that the predictive horizon set by climate interannual variability is 2–6 years, after which only an asymptotic probability distribution of stock properties, such as biomass, is predictable.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Population Ecology and Genetics
Authors: Christensen, A. (Intern), Butenschön, M. (Ekstern), Gürkan, Z. (Intern), Allen, I. (Ekstern)
Publication date: 2012
Event:
Publication: Research › Conference abstract for conference – Annual report year: 2012

Effect of the Horns Rev 1 Offshore Wind Farm on Fish Communities. Follow-up Seven Years after Construction: Follow-up Seven Years after Construction

General information
State: Published
Organisations: Section for Coastal Ecology, National Institute of Aquatic Resources, Section for Population Ecology and Genetics, Mathematical Statistics, Department of Informatics and Mathematical Modeling
Number of pages: 96
Publication date: 2011

Publication information
Place of publication: Charlottenlund
Publisher: DTU Aqua. Institut for Akvatiske Ressourcer
ISBN (Print): 978-87-7481-142-8
Original language: English
Series: DTU Aqua Report
Number: 246-2011
ISSN: 1395-8216
Main Research Area: Technical/natural sciences
Electronic versions:
246_2011_effect_of_the_horns_rev_1_offshore_wind_farm_on_fish_communities.pdf
Publication: Commissioned › Report – Annual report year: 2012

General classification of maturation reaction-norm shape from size-based processes
Phenotypic plasticity of size at maturation is commonly described using size–age maturation reaction norms (MRNs). MRNs for age and size at maturation are analyzed and classified into three general categories related to different size scalings of growth and mortality. The underlying model for growth and mortality is based on processes at the level of the individual, and is motivated by the energy budget of fish. MRN shape is a balance between opposing factors and depends on subtle details of size dependence of growth and mortality. MRNs with both positive and negative slopes are predicted, and for certain mortality conditions also a lower critical spawning mass. The model is applied to predict a generic fishery-induced evolutionary response and allows assessment of climate change impact on MRNs. Our work stresses the importance of using realistic size dependence of mortality and growth, since this strongly influences the predicted MRNs and sensitivity to harvest pressure.

General information
State: Published
Organisations: Section for Population Ecology and Genetics, National Institute of Aquatic Resources
Authors: Christensen, A. (Intern), Andersen, K. H. (Intern)
Pages: 1004-1027
Publication date: 2011
Disentangling climate from anthropogenic effects: From: Resolving climate impacts on fish stocks
Growth and survival of larval and early juvenile lesser sandeel in patchy prey field in the North Sea: An examination using individual-based modelling

Modelling the spatio-temporal dynamics in growth and survival of larval cod and sandeel in the North Sea by using individual-based models integrated with spatially explicit three-dimensional hydrodynamic and biogeochemical models
Sandeels: From: Resolving climate impacts of fish stocks

General information
State: Published
Organisations: Section for Population Ecology and Genetics, National Institute of Aquatic Resources
Authors: Jensen, H. (Ekstern), Christensen, A. (Intern)
Publication date: 2010

Publication information
Place of publication: Copenhagen
Publisher: International Council for the Exploration of the Sea
Volume: 16
ISBN (Print): 978-87-7482-071-0
Original language: English
Series: Cooperative Research Report
Number: 301
Main Research Area: Technical/natural sciences
Links:
http://www.ices.dk/pubs/crr/crr301/CRR%20301-Web-100531.pdf

The effect of patchiness in prey on the growth of larval lesser sandeel in the North Sea: An examination using Individual-Based Modelling

General information
State: Published
Organisations: Section for Population- and Ecosystem Dynamics, National Institute of Aquatic Resources
Authors: Gürkan, Z. (Intern), Christensen, A. (Intern), Mosegaard, H. (Intern)
Publication date: 2010
Main Research Area: Technical/natural sciences
Links:

The role of spatial processes in North Sea herring larval survival and recruitment

General information
State: Published
Organisations: Section for Ocean Ecology and Climate, National Institute of Aquatic Resources, Section for Population Ecology and Genetics
Authors: Payne, M. (Intern), Christensen, A. (Intern), Munk, P. (Intern), Nash, R. D. (Ekstern), Dickey-Collas, M. (Ekstern)
Publication date: 2010
Main Research Area: Technical/natural sciences
Links:
http://www.ices.dk/products/cmdocsindex.asp

Adaptive foraging behaviour and the role of the overwintering strategy
Automated Fish Ageing (AFISA)

Individual-based modeling of growth and survival of Atlantic cod and lesser sandeel larval and juvenile stages

Individual based modeling of growth and survival of Atlantic cod (Gadus morhua) and lesser sandeel (Ammodytes marinus) larval stages
Recruitment in a changing environment: the role of oceanographic processes in blue whiting population dynamics

Spatially resolved fish population analysis for designing MPAs: influence on inside and neighbouring habitats

Spatially resolved fish population analysis for designing MPAs: influence on inside and neighbouring habitats
Bank resolved prognoses of sandeel fishing potential in the North Sea

General information
State: Published
Organisations: Section for Population Ecology and Genetics, National Institute of Aquatic Resources
Authors: Christensen, A. (Intern)
Number of pages: 18
Publication date: 2008

Publication information
Original language: English
Main Research Area: Technical/natural sciences
Electronic versions:
Sandeel (Ammodytes marinus) larval transport patterns in the North Sea from an individual-based hydrodynamic egg and larval model

We have calculated a time series of larval transport indices for the central and southern North Sea covering 1970-2004, using a combined three-dimensional hydrodynamic and individual-based modelling framework for studying sandeel (Ammodytes marinus) eggs, larval transport, and growth. The egg phase is modelled by a stochastic, nonlinear degree-day model describing the extended hatch period. The larval growth model is parameterized by individually back-tracking the local physical environment of larval survivors from their catch location and catch time. Using a detailed map of sandeel habitats in the North Sea, the importance of hydrography for early life stages of sandeel to their recruitment success is explored. We find that the sandeel larval transport patterns in the North Sea are relatively robust toward uncertainties in biological parameters, when mortality aspects are included. We find only weak spatiotemporal correlations between elements of the transport indices in the time series, mainly positive correlation between retention terms for the same year. The transport connectivity of sandeel habitats in the North Sea and the dynamical properties of the North Sea transport system are also analyzed, and we introduce novel a scheme to quantify direct and indirect connectivity on equal footings in terms of an interbank transit time scale.
Hydrodynamic backtracking of fish larvae by individual-based modelling

General information
State: Published
Organisations: Section for Population- and Ecosystem Dynamics, National Institute of Aquatic Resources, Section for Population Ecology and Genetics
Accelerating convergence of molecular dynamics-based structural relaxation
We describe strategies to accelerate the terminal stage of molecular dynamics (MD) based relaxation algorithms, where a large fraction of the computational resources are used. First, we analyze the qualitative and quantitative behavior of the QuickMin family of MD relaxation algorithms and explore the influence of spectral properties and dimensionality of the molecular system on the algorithm efficiency. We test two algorithms, the MinMax and Lanczos, for spectral estimation from an MD trajectory, and use this to derive a practical scheme of time step adaptation in MD relaxation algorithms to improve efficiency. We also discuss the implementation aspects. Secondly, we explore the final state refinement acceleration by a combination with the conjugate gradient technique, where the key ingredient is an implicit corrector step. Finally, we test the feasibility of passive Hessian matrix accumulation from an MD trajectory, as another route for final phase acceleration. Our suggestions may be implemented within most MD quench implementations with a few, straightforward lines of code, thus maintaining the appealing simplicity of the MD quench algorithms. In this paper, we also bridge the conceptual gap between the MD quench algorithms inspired from physics and the mathematically rooted line search algorithms.

General information
State: Published
Organisations: Section for Population- and Ecosystem Dynamics, National Institute of Aquatic Resources
Authors: Christensen, A. (Intern)
Pages: 193-223
Publication date: 2005
Main Research Area: Technical/natural sciences

Publication information
Journal: International Journal of Modern Physics C
Volume: 16
Issue number: 2
ISSN (Print): 0129-1831
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
Scopus rating (2016): SJR 0.347 SNIP 0.581 CiteScore 0.99
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.37 SNIP 0.564 CiteScore 0.96
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.35 SNIP 0.694 CiteScore 1.02
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.386 SNIP 0.594 CiteScore 0.89
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.316 SNIP 0.482 CiteScore 0.69
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.332 SNIP 0.531 CiteScore 0.78
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.434 SNIP 0.417
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.5 SNIP 0.65
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.393 SNIP 0.552
Scopus rating (2007): SJR 0.495 SNIP 0.534
Web of Science (2007): Indexed yes
Adhesion of ultrathin ZrO\textsubscript{2}(111) films on Ni(111) from first principles

We have studied the ZrO\textsubscript{2}(111)/Ni(111) interface using the ultrasoft pseudopotential formalism within density functional theory. We find that ZrO\textsubscript{2}(111) adheres relatively strongly at the monolayer level but thicker ceramic films interact weakly with the Ni-substrate. We argue that the cohesion changes character from dominantly image charge interactions for thick ceramic films to more covalent for monolayer ZrO\textsubscript{2}(111) films. We provide an analysis of energetic, structural, and electronic aspects of the ZrO\textsubscript{2}/Ni interface as a function of the thickness of the oxide layer. We also address the role of the exchange-correlation density functional parameterization for modeling the oxide and metal/oxide interface and discuss the sensitivity of the supercell approximation for metal/oxide interface properties.

General information
State: Published
Organisations: Department of Physics, University of California
Authors: Christensen, A. (Intern), Carter, E. A. (Ekstern)
Pages: 5816-5831
Publication date: 2001
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Chemical Physics
Volume: 114
Issue number: 13
ISSN (Print): 0021-9606
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 2.13 SJR 1.073 SNIP 0.755
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 0.953 SNIP 0.767 CiteScore 1.98
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.386 SNIP 0.989 CiteScore 2.54
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.532 SNIP 1.17 CiteScore 2.95
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.787 SNIP 1.118 CiteScore 2.86
ISI indexed (2012): ISI indexed yes
Weak bonding of alumina coatings on Ni(111)

General information
State: Published
Organisations: University of California
Authors: Jarvis, E. (Ekstern), Christensen, A. (Intern)
Pages: 55-76
Publication date: 2001
First-principles characterization of a heteroceramic interface: ZrO2(001) deposited on an alpha-Al2O3(1102) substrate

We have studied an alumina/zirconia interface using the all-electron projector augmented wave formalism within density functional theory. We present the electronic, structural, and energetic properties of the ZrO2(001)/(alpha-Al2O3(1 (1) over bar 02) interface as well as of the free alpha-Al2O3(1 (1) over bar 02) and ZrO2(001) surfaces. We find that the generalized gradient correction significantly lowers the oxide surface energies, compared to values obtained by the local density approximation. The monoclinic-tetragonal transition in ZrO2(001) thin films is discussed as well as strain effects involved in the interface formation. The stoichiometric alumina/zirconia interface is found to be weakly bonded, regardless of the film thickness, and the ZrO2(001)/alpha-Al2O3(1 (1) over bar 02) interface has a rather epitaxial character, due to a low lattice mismatch of similar to 4%. The impact of such weak interactions on ceramic coating stability is discussed.
Scopus rating (2007): SJR 2.923 SNIP 1.546
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 2.796 SNIP 1.56
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 2.763 SNIP 1.607
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 2.742 SNIP 1.606
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 2.75 SNIP 1.536
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 2.788 SNIP 1.706
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 2.946 SNIP 1.635
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 2.986 SNIP 1.631
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 3.115 SNIP 1.58
Original language: English
TOTAL-ENERGY CALCULATIONS, TETRAGONAL ZIRCONIA, INHOMOGENEOUS ELECTRON-GAS, PROJECTOR AUGMENTED-WAVE, MARTENSITIC PHASE-TRANSFORMATION, STRUCTURAL-PROPERTIES, YTTRIA-STABILIZED ZIRCONIA, MOLECULAR-DYNAMICS, AB-INITIO, THERMAL-BARRIER COATINGS
Electronic versions:
Emily.pdf
DOIs:
10.1103/PhysRevB.62.16968
Links:

Bibliographical note
Copyright (2000) American Physical Society
Source: orbit
Source-ID: 258210
Publication: Research - peer-review › Journal article – Annual report year: 2000

Atomic-level properties of thermal barrier coatings: Characterization of metal- ceramic interfaces

General information
State: Published
Organisations: University of California, Los Angeles
Authors: Christensen, A. (Intern), Jarvis, E. (Ekstern), Carter, E. (Ekstern)
Number of pages: 632
Pages: 490-546
Publication date: 1999

Host publication information
Title of host publication: Chemical Dynamics in Extreme Environments
Editors: Dressler, R. A., Ng, C.
ISBN (Print): 9789812811882

Series: Advanced Series in Physical Chemistry
Main Research Area: Technical/natural sciences
Electronic versions:
EAC-111.pdf
Source: orbit
Source-ID: 278367
Publication: Research - peer-review › Book chapter – Annual report year: 1999

First principles study of the surfaces of Zirconia

General information
We discuss surface alloy phases and their stability based on surface phase diagrams constructed from the surface energy as a function of the surface composition. We show that in the simplest cases of pseudomorphic overlayers there are four generic classes of systems, characterized by the sign of the heat of segregation from the bulk and the sign of the excess interactions between the atoms in the surface (the surface mixing energy). We also consider the more complicated cases of ordered surface phases, nonpseudomorphic overlayers, second layer segregation, and multilayers. The discussion is based on density-functional calculations using the coherent-potential approximation and on effective-medium theory. We give self-consistent density-functional results for the segregation energy and surface mixing energy for all combinations of the transition and noble metals. Finally we discuss in detail the cases Ag/Cu(100), Pt/Cu(111), Ag/Pt(111), Co/Cu(111), Fe/Cu(111), and Pd/Cu(110) in connection with available experimental results.
A recent dynamical LEED study [G.N. Derry, C.B. McVey, P.J. Rous, Surf. Sci. 326 (1995) 59] reported an oscillatory surface segregation profile in the Ni50Pd50(100) system with the surface layer enriched by Pd. We have performed ab-initio total-energy calculations for the surface of this alloy system using the coherent potential approximation and obtain an oscillatory segregation profile, in agreement with experiments. We discuss the energetic origin of the oscillatory segregation profile in terms of effective cluster interactions. We include relaxation effects by means of the semi-empirical effective medium theory, and find that this cannot explain the remaining differences between theory and experiment. (C) 1997 Elsevier Science B.V.
Interatomic interactions in metals

General information
State: Published
Organisations: Department of Physics
Authors: Christensen, A. (Intern)
Size dependence of phase separation in small bimetallic clusters

General information
State: Published
Organisations: Technical University of Denmark
Authors: Christensen, A. (Intern), Stoltze, P. (Intern), Nørskov, J. (Ekstern)
Pages: 1047
Publication date: 1995
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Physics: Condensed Matter
Volume: 7
ISSN (Print): 0953-8984
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
Scopus rating (2016): CiteScore 1.89 SJR 0.881 SNIP 0.754
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.824 SNIP 0.754 CiteScore 1.65
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.217 SNIP 0.951 CiteScore 1.99
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.297 SNIP 1.022 CiteScore 2.11
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.659 SNIP 1.166 CiteScore 2.33
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.627 SNIP 1.166 CiteScore 2.31
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.654 SNIP 1.053
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.529 SNIP 1.019
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.475 SNIP 1.08
Web of Science (2008): Indexed yes
Projects:

Creating the scientific foundation for alternative ways of managing North Sea sandeel

National Institute of Aquatic Resources
Period: 15/02/2017 → 14/02/2020
Number of participants: 3
Phd Student:
Henriksen, Ole (Intern)
Supervisor:
Christensen, Asbjørn (Intern)
Main Supervisor:
vandeurs, Mikael (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: Samfinansieret - Andet

Relations
Activities:
Forvaltning af Tobis i Nordsøen
ICES - Herring Assessment Working Group for the Area South of 62°N - HAWG
Project: PhD

Eastern Baltic cod - New knowledge of growth and mortality is the way to improved management advice (39366)
The aim of the project is to improve the knowledge and data basis for stock assessment and management for cod in the eastern Baltic Sea.

In later years, changes in growth and natural mortality of cod have presumably taken place and new knowledge on these parameters is essential for restoring analytical stock assessment for Eastern Baltic cod that is currently lacking. Improved knowledge on cod growth and mortality is therefore a prerequisite for being able to evaluate the stock status in relation to management targets and implement management plans that are built on quantitative stock assessment.

Ecological situation in the Baltic Sea has changed in later years, which requires updated biological information. This is done in the project using different approaches, bringing together expertise of different research areas. The approaches...
applied include molecular-genetic analyses of cod growth, bioenergetic modelling, and analyses of monitoring data on predation and condition/growth of cod. An important component of the project is cooperation with fishing industry to support tagging experiments of Baltic cod, to obtain updated estimates of cod growth.

Finally, the project combines the new knowledge on cod that becomes available from this and other relevant projects to ensure that the assessment of stocks status and management advice is based on best available scientific information.

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 Ecosystem based Marine Management
Danish Fishermen’s Association
University of Copenhagen
Period: 15/08/2016 → 15/08/2018
Number of participants: 8
Research areas: Ecosystem based Marine Management & Fish Biology & Marine Populations and Ecosystem Dynamics & Population Genetics & Marine Living Resources & Fisheries Management
Project participant:
Storr-Paulsen, Marie (Intern)
Tomkiewicz, Jonna (Intern)
Hansen, Jakob Hemmer (Intern)
Neuenfeldt, Stefan (Intern)
Christensen, Asbjørn (Intern)
Kindt-Larsen, Lotte (Intern)
Berg, Casper Willestofte (Intern)
Project Coordinator:
Eero, Margit (Intern)

Evaluation of Sustainable Exploitation of Major Baltic Fish Stocks under different Climate, Eutrophication and Fishing Pressures

National Institute of Aquatic Resources
Period: 01/07/2016 → 30/06/2019
Number of participants: 5
PhD Student:
Bossier, Sieme (Intern)
Supervisor:
Bastardie, Francois (Intern)
Christensen, Asbjørn (Intern)
Main Supervisor:
Nielsen, J. Rasmus (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: Samfinansieret - Andet
Project: PhD

Ballast water - Tool for supporting the delimitation of a "same risk area" (39348)
A project financed by the Danish Maritime Fund via the Danish Nature Agency, to develop a decision support tool for authorities and consultants involved with the ballast water convention and measures preventing the spread of marine invasive species. The tool will support decision makers in member nations of the International Maritime Organisation (IMO) to identify and delimit marine areas with high connectivity considering hydrography and species biology. Identification of marine areas with high connectivity can provide a basis for granting exemptions in relation to the ballast water convention and the requirement for ships to treat ballast water before being discharged into the sea. The tool development is based on existing freeware including "IBM Lib" (DTU Aqua’s own individual-based modeling system for linking individual-based models to hydrographical model data), Netlogo (a widely used IBM simulation system) and R (a
statistical programming and data handling package).

This project is coordinated by DTU Aqua.

The project is funded by the Danish Maritime Fund via the Danish Nature Agency.

National Institute of Aquatic Resources
Section for Marine Living Resources
Danish Meteorological Institute
Anchor-Lab

Period: 01/03/2016 → 01/12/2016
Number of participants: 9
Research areas: Marine Living Resources & Observation Technology

Project participant:
Mosegaard, Henrik (Intern)
Stage, Bjarne (Intern)
Eg Nielsen, Einar (Intern)
Worsøe Clausen, Lotte (Intern)
von Deurs, Mikael (Intern)
Andersen, Niels Gerner (Intern)

Project Manager, organisational:
Pedersen, Eva Maria (Intern)

Project Manager, academic:
Hansen, Flemming Thorbjørn (Intern)

Project Coordinator:
Christensen, Asbjørn (Intern)

Project Forward management of sandeel in the North Sea (39316)

The project will define and align the management of sandeel considering the goals and desires of the fishing industry, administration and science while taking the biology and importance of the sandeel in the ecosystem into account.

The project is structured by several work-packages, each dealing with specific aspects of sandeel biology and/or fishery relevant for management. Among these will the sandeel population structure and its influence on stock assessment, CPUE and counselling be discussed. Analyses of fisheries development and sandeel availability over the fishing season will enable a more accurate calculation of fishing mortality. Furthermore, it is examined whether the increasing concentration of fishing effort on certain banks potentially causes an error in the stock assessment in relation to recruitment from unfished banks. The project will perform a statistical evaluation of fisheries-independent data for sandeel in the North Sea and evaluate existing and alternative methods of stock assessment for sandeel in the North Sea with current and alternative management areas, including implementing an analytical stock assessment of sandeel in sandeel area 4. Finally the project will evaluate existing biological and management reference points, and discuss these in relation to ecosystem reference points.

Throughout the project period, a series of workshops and meetings will be held in order to discuss possible management strategies for sandeel in the North Sea. These discussions will imply a number of fundamental prerequisites defined in collaboration between management, fisheries and science in order to form the basis for an optimal management of sandeel.

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 Pelagic Producers Organisation
Danish Fishermen's Association
Marine Ingredients Denmark
Period: 11/11/2015 → 16/11/2017
Number of participants: 8
Research areas: Marine Living Resources & Population Genetics & Fish Biology & Marine Populations and Ecosystem Dynamics & Fisheries Management & Ecosystem based Marine Management
Project participant:
Rindorf, Anna (Intern)
von Deurs, Mikael (Intern)
Berg, Casper Willestofte (Intern)
Mosegaard, Henrik (Intern)
Bekkevold, Dorte (Intern)
Mortensen, Lars O. (Intern)
Christensen, Asbjørn (Intern)
Project Coordinator:
Worsøe Clausen, Lotte (Intern)

**Baltic Sea Check Point (BSCP) (39294)**
The overall aim of this project is to examine the current data collection, observation, surveying, sampling and data assembly programs in the Baltic Sea basin, assess and demonstrate how they can fit into purpose in the 11 challenge areas in terms of data uncertainty, availability, accessibility and adequacy, and deliver the findings to stakeholders through an internet portal with dynamic mapping features and a stakeholder workshop. The Baltic Sea region is as defined by the Marine Strategy Framework Directive, i.e., the semi-enclose sea bounded by the parallel of the Skaw in the Skagerrak at 57°44.43'. This project is coordinated by the Danish Meteorological Institute. The project is funded by the EU Executive Agency for Small and Medium-sized Enterprises (EASME) & 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 Meteorological Institute
Klaipeda University
European Global Ocean Observing System
Finnish Meteorological Institute
ETT S.p.A
Swedish Maritime Administration
Tshwane University of Technology
Grontmij A/S

Period: 17/09/2015 → 16/06/2018
Number of participants: 3
Research areas: Marine Living Resources & Coastal Ecology & Ecosystem based Marine Management
Project participant:
Dinesen, Grete E. (Intern)
Eero, Margit (Intern)
Project Coordinator:
Christensen, Asbjørn (Intern)

**Dynamic user-driven marine e-maps for the advancement of Danish industrial fisheries (GUPD-VIND) (39246)**
This project aims at strengthening Danish industrial fisheries development in order to (i) reduce the search time and fuel consumption per ton of fish caught (revenues: 16 million DKK/year), (ii) make better use of the sprat quota (revenues: 15 million DKK/year, by a full quota uptake), (iii) pave the way for sustainable self-management of resources in the industrial fisheries sector and (iv) contribute to creating and maintaining jobs in the local fishing community.

The specific objectives of the project: Development of an IT tool that will contain (i) a platform to improve sharing of knowledge and registration of observable and derived variables (data), and (ii) user-defined and user-controlled digital Marine Maps with those specific data that fishermen consider important as background information in the planning and implementation of fishing trips. These marine data include (but are not limited to) a portfolio of Marine Maps spanning from the North Sea hydrography and bottom conditions over distribution of plankton and fish to water-DNA.
The needs for a technological development of this fishery comes from increasing average vessel size, while the number of large vessels is reduced to about 1/8 of what it was in the past. The immediate consequence is a reduction in the collective search performance and knowledge sharing. In addition, the area based management of the sandeel fishery introduced in 2011 has contributed to a reduction of fishermen's opportunities to diversify fishing and explore a wider variety of fishing grounds. Finally, the sprat fishery is uncertain because of by-catch limits and a very variable CPUE driven by wind and weather. This has led to an underutilization of the sprat quota by around 100,000 tons per year. Fisherman knowledge of good fishing opportunities is based on the correspondence between historical catches and observable variables at the time of capture, such as the seasons, wind, waves and tides, and it is precisely this kind of knowledge that the project wants to combine with a technological solution, so that all relevant data is made widely available to the fishermen by developing user-controlled dynamic digital Marine Maps. The project includes a business plan for the IT company Anchor Lab, which develops the user-controlled Marine Maps, and plans for derived effects in terms of better utilization of the sprat quota and fuel savings through the use of the Marine Maps. Besides the economic effects, the project contributes to CO2 reduction, and supports the technological development of a modern industrial fishery sector, based on a natural resource to be managed by the EU in accordance with ICES’ advice.

This project is coordinated by DTU Aqua.

The project is funded by the Ministry of Environment and Food of Denmark through the Green Development and Demonstration Program (GUDP).

National Institute of Aquatic Resources
Section for Marine Living Resources
Danish Meteorological Institute
Anchor-Lab
Period: 01/01/2015 → 30/06/2018
Number of participants: 8
Research areas: Marine Living Resources & Marine Populations and Ecosystem Dynamics & Population Genetics & Observation Technology
Project participant:
Christensen, Asbjørn (Intern)
Stage, Bjarne (Intern)
Eg Nielsen, Einar (Intern)
Worsøe Clausen, Lotte (Intern)
van Deurs, Mikael (Intern)
Andersen, Niels Gerner (Intern)
Project Manager, organisational:
Pedersen, Eva Maria (Intern)
Project Coordinator:
Mosegaard, Henrik (Intern)

Modelling the role of competition between fish and jellyfish in marine pelagic ecosystems

National Institute of Aquatic Resources
Period: 01/08/2014 → 05/12/2017
Number of participants: 6
Phd Student:
Schnedler-Meyer, Nicolas Azaña (Intern)
Supervisor:
Kiørboe, Thomas (Intern)
Main Supervisor:
Mariani, Patrizio (Intern)
Examiner:
Christensen, Asbjørn (Intern)
Huse, Geir (Ekstern)
Tiselius, Peter (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Samfinansieret - Andet
Short-term projections for short-lived species managed under MSY: Management of the sandeel stock in the North Sea (39148)

The industrial fishery for small short-lived species represents the economically most important fishery in Denmark, and traditionally the North Sea sandeel (Ammodytes marinus) has played a key role in this fishery. Currently, quota advice for sandeel is based on the so-called B-escapement strategy, the purposes of which is to ensure that the spawning stock biomass remains large enough to maintain the survival of the population even after fish-eating fish, birds, and mammals have taken their share; and whatever is left is made available to the fishery. This type of management strategy relies on accurate predictions about the size of the incoming year class (the recruitment), if the criteria of MSY are to be fulfilled.

The aim of the project was therefore to ensure that the short-term prognosis reflects current knowledge about the biology of sandeels in the North Sea and applies all relevant data time-series. A new recruitment index was introduced. Seasonal and spatial patterns in log-book based catch rates of age-1 fish were analysed and compared to recruitment indices from the year before. Spatial differences in local larval retention strength were found. A genetic tool that allowed us to distinguish between different sandeel species in a quick and accurate way was developed. Lastly, development of a state based assessment model that can handle seasonal data (something which is necessary for sandeel) and estimate shifting selection patterns was initiated.

All of this work is currently contributing significantly to the preparation of the coming North Sea sandeel benchmark assessment in ICES to be held in the fall of 2016.

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 Marine Living Resources
Sir Alister Hardy Foundation for Ocean Science
Centre for Environment Fisheries and Aquaculture Science
Period: 22/07/2013 → 01/05/2015
Number of participants: 6
Research areas: Marine Living Resources & Population Genetics
Project participant:
Mosegaard, Henrik (Intern)
Azour, Farivar (Intern)
Christensen, Asbjørn (Intern)
Bekkevold, Dorte (Intern)
Project Manager, academic:
Worsøe Clausen, Lotte (Intern)
Project Coordinator:
von Deurs, Mikael (Intern)

Analysis of measures for increased stability in the industrial fisheries (39027)

The objective of the project "Analysis of measures for increased stability in the industrial fisheries" has been to improve fisheries advice to ensure more stable quotas for the three main industrial species in the North Sea; sandeel, sprat and Norway pout. The means to get there was to improve data, calculation procedure and management plans by taking into account the special conditions that exist for each species.

Through an industry-scientist-manager collaboration platform initiatives were taken to a theoretically and practical cooperation, where collection and analysis of biological and fishery-based data and knowledge sharing between fisheries, bio-economy, management and research has supported development of robust management strategies that may increase economic stability in the industry if implemented in the future.

The project is 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
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 a 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 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. a decoupling 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).
**Trait-based analysis and modelling of fish communities**

National Institute of Aquatic Resources  
**Period:** 01/03/2012 → 01/07/2015  
**Number of participants:** 6  
**PhD Student:**  
Olsson, Karin (Intern)  
**Supervisor:**  
Andersen, Ken Haste (Intern)  
**Main Supervisor:**  
Gislason, Henrik (Intern)  
**Examiner:**  
Christensen, Asbjørn (Intern)  
Falster, Daniel (Ekstern)  
Jørgensen, Christian (Ekstern)

**Financing sources**  
**Source:** Internal funding (public)  
**Name of research programme:** 1/3 FUU, 1/3 inst 1/3 Andet  
**Project:** PhD

**A coast to coast network of protected areas: From the shore to the deep sea (CoCoNet) (38863)**

The project targeted design and implementation of marine protected areas, as well as advancement of the scientific basis for optimal design and implementation. The project focused on two pilot studies in the Mediterranean and Black Sea for establishing a network of MPAs.

DTU Aqua participated in developing the scientific basis for optimal design of MPA networks by developing spatial size-based models to describe biodiversity as appropriate scales, as well as habitat connectivity from trait-based modelling, and procedures for analyzing habitat connectivity. DTU Aqua also contributed to governance issues relating to establishment of MPA networks.

The project had 39 partners from the EU and Eastern Europe and Near Asia.

The project was coordinated by Universita del Salento, Italy.

The project was funded by EU, Framework Programme 7.

National Institute of Aquatic Resources  
**Section for Marine Living Resources**  
**Period:** 01/01/2012 → 31/01/2016  
**Number of participants:** 4  
**Research areas:** Marine Living Resources & Oceanography & Ecosystem based Marine Management  
**Project participant:**  
Sørensen, Thomas Kirk (Intern)  
Mariani, Patrizio (Intern)  
Kiørboe, Thomas (Intern)  
**Project Manager, academic:**  
Christensen, Asbjørn (Intern)  
**Project:**
MyOcean 2 (38862)
The project advanced and coordinated European scientific and technical infrastructure in the European operational
oceanography community, for collecting and distributing ocean observations and ocean forecasts, being a continuation of
MyOcean. DTU Aqua was reference intermediate user (RIU) in WP3 aimed at integrating MyOcean products into national
systems and services and foster downstream exploitation of MyOcean information especially at a regional level.

The project had 61 partners from the EU and was coordinated by Mercator Ocean, France.

The project was funded by EU, Framework Programme 7.

National Institute of Aquatic Resources

Operational ecology: Ecosystem forecast products to enhance marine GMES applications (OPEC) (38864)
The primary goal of OPEC was to improve the quality of operational services for biogeochemical and ecological
parameters and hence, improve our ability to project the future status of European marine ecosystems, by delivering a
suite of error quantified indicators which describe changes in ecosystem function suitable for implementation in operational
centers.

In order to advance our understanding and predictive capacities for the response of marine ecosystems to global
change, OPEC employed a combination of numerical simulations, data assimilation of satellite and in situ data,
observational strategy evaluation and cross-disciplinary synthesis. The MSFD takes a regional approach to the
development of strategies for environmental status, identifying four main regions: NE Atlantic, Baltic, Mediterranean and
Black Seas. The MSFD also identifies a number of high level descriptors of environmental status (e.g. biodiversity,
commercial fish, eutrophication, food webs, and invasive species) each of which has a defined set of indicators. Using the
regional approach as framework we implemented and tested a suite of indicators in each region. These descriptors along
with the ECVs provided a framework for the definition of new environmental applications (e.g. habitat for biodiversity,
oxigen depletion/eutrophication, fisheries and marine climate change research).

A common set of descriptors with associated GES indicators and ECVs were defined across the four regions, to ensure
a commonality of approach and the development of a consistent capacity across Europe. Auditable quality is essential for
GMES environmental applications, and OPEC emphasized the assessment of predictability of key indicators. The R&D of
the project included development of coupled end to end ecosystem models, where DTU Aqua implemented the coupling
between the SMS model for higher trophic levels and HBM-ERGOM for physics and biogeochemistry.

The project had nine partners from the EU and was coordinated by Plymouth Marine Laboratory, UK.

The project was funded by EU. Framework Programme 7.

National Institute of Aquatic Resources

Operational ecology: Ecosystem forecast products to enhance marine GMES applications (OPEC) (38864)
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development of strategies for environmental status, identifying four main regions: NE Atlantic, Baltic, Mediterranean and
Black Seas. The MSFD also identifies a number of high level descriptors of environmental status (e.g. biodiversity,
commercial fish, eutrophication, food webs, and invasive species) each of which has a defined set of indicators. Using the
regional approach as framework we implemented and tested a suite of indicators in each region. These descriptors along
with the ECVs provided a framework for the definition of new environmental applications (e.g. habitat for biodiversity,
oxigen depletion/eutrophication, fisheries and marine climate change research).

A common set of descriptors with associated GES indicators and ECVs were defined across the four regions, to ensure
a commonality of approach and the development of a consistent capacity across Europe. Auditable quality is essential for
GMES environmental applications, and OPEC emphasized the assessment of predictability of key indicators. The R&D of
the project included development of coupled end to end ecosystem models, where DTU Aqua implemented the coupling
between the SMS model for higher trophic levels and HBM-ERGOM for physics and biogeochemistry.

The project had nine partners from the EU and was coordinated by Plymouth Marine Laboratory, UK.

The project was funded by EU. Framework Programme 7.

National Institute of Aquatic Resources

North Atlantic - Arctic coupling in a changing climate: Impacts on ocean circulation, carbon cycling and sea-ice (NAACOS)
(38888)
Climate change is most pronounced at high latitudes, with rapid and dramatic changes observed in sea-ice coverage,
circulation and the ecosystem. These changes have profound effects both at the regional scale as well as globally.
The North Atlantic and Arctic Ocean are the headwaters of the thermohaline circulation (THC), the global heat engine responsible, amongst other things, for the relatively mild climate we experience in Denmark. Subtle change in sea-ice formation, deep water circulation, and freshwater supply on a relatively local scale will have repercussions around the world. More subtle still are the feedback controls these processes have on climate change. Sea-ice coverage and the earth’s albedo is one feedback, but there is also the draw down and sequestering of atmospheric CO2 in deep waters by physical and biological processes. The whole is an intricate weave of interrelated mechanisms: the scientific challenge to draw together expertise across disciplines to address these issues was accomplished; the strategic outcome was a suite of knowledge-based tools designed to reduce the uncertainty and contribute to climate policies.

The NAACOS team comprised a number of well-recognized scientists with profound experience and a significant international collaboration. NAACOS developed and refined oceanographic models using remote sensing and observations to evaluate the impact of high latitude climate change on circulation, deep water formation, sea-ice and carbon flux, and their implications at regional scales.

The project was coordinated by DTU Aqua.

The project was funded by the Danish Council for Strategic Research and a DHI student stipend.

National Institute of Aquatic Resources
Section for Marine Ecology and Oceanography
Danish Meteorological Institute
Aarhus University
DHI Denmark
Faroe Research Institute
University of Copenhagen
Period: 01/01/2011 → 31/12/2014
Number of participants: 6
Research areas: Oceanography & Marine Populations and Ecosystem Dynamics & Marine Living Resources
Project participant:
Stedmon, Colin (Intern)
Koski, Marja (Intern)
Mariani, Patrizio (Intern)
Christensen, Asbjørn (Intern)
Jonasdottir, Sigrun (Intern)
Project Manager, academic:
Visser, Andre (Intern)

Optimal sustainable exploitation of Nephrops norvegicus in Kattegat and Skagerrak (38909)

The scientific advice on management of fisheries is primarily aiming at avoiding overfishing of the fish and shellfish stocks and only to a very limited extend addresses how the utilisation of the resources can be optimised within a sustainable ecosystem framework. An example is the regulation of the demersal trawl fisheries in the Skagerrak and the Kattegat which to protect the cod stock is sub-optimal in relation to the utilisation of the Norway lobster (Nephrops) stocks. The project takes a new approach to the management and aims at optimising the utilisation of Nephrops stocks without compromising the protection of cod.

The Nephrops fishery is one of the economically most important fisheries in Denmark. In the Kattegat and Skagerrak, Nephrops catches accounted in 2010 for 53 % and 25 % of the total value of fish and shellfish, respectively, landed by Danish fishermen. Cod is taken as by-catch in the Nephrops fishery and it has been necessary to introduce measures to limit the by-catches of cod, which is currently below agreed reference points for stock size. These measures have had a negative impact on Nephrops catches.

The project addressed four objectives: (i) development of advice on the fishing mortality for the Nephrops stocks, which is consistent with maximum sustainable yield; (ii) mapping of the distribution of Nephrops in Skagerrak and Kattegat; (iii) development of a new trawl concept optimising the catchability on Nephrops while limiting the by-catches of cod and impact on the sea bed; and (iv) evaluating alternative fishing methods for Nephrops including fishing with pots.

The project was coordinated by DTU Aqua.

The project was funded by the Danish Ministry of Food, Agriculture and Fisheries through the Green Development and Demonstration Program (GUDP).
Geographical distribution of fish resources and optimizing of fishery practice in the north-eastern North Sea (RESOURCE)

(38878)

RESOURCE 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.
Background and Objectives

Management of terrestrial and aquatic ecosystems is legally defined in several European directives. The scientific basis for implementing the directives has been limited by insufficient models, deficiencies in terms of uncertainties, local and regional aspects and lack of knowledge on the interplay between agriculture, fishery, environmental qualities in all surface waters, and economy. The project aimed to establish an interdisciplinary and international approach designed to establish a body of knowledge to develop tools, models, scenarios and predictions in order to integrate science and management from agriculture, fishery, aquatic environments and economy into a common platform. The main aims were to link the complex interplay between land use in the drainage basins, the transport of nutrients to water bodies, biogeochemistry of freshwater and marine water, marine ecosystem dynamics and the removal of biomass and nutrients in marine fisheries all integrated into a management strategy evaluation (MSE) framework consisting of linked catchment area and river-run-off models, marine bio-geo-chemical models, end-to-end marine ecosystem models, fishery models, economic and cost-minimization models, and ecosystem services assessments models. Such a complex model and MSE framework could be used to assess effects of changing market conditions, changed agricultural and fishery support policies, as well as fulfillments of water related directives.

Tasks and Deliverables

The Danish Strategic Research Council financed project IMAGE was a strategic research alliance between central Danish and international fisheries and marine environment based university institutes. The project integrated, educated, and trained new researchers and private and public end-users to develop and work with a number of empirical and dynamic models and management tools, further developed into cross traditional media and science-based decision support systems, to strengthen national and international environmental management. The results published in a high number of scientific peer reviewed articles have provided major scientific progress. The results and research quality included analyses of novel processes and development of new and improved models, integrated prognoses and scenarios for the interplay between changes in the drainage basins and the ecological and economic consequences, and a number of science-based decision support tools. The work involved (i) identification of key elements and reduction of uncertainties in using complex models, (ii) designing, developing and integrating important new concepts in the models, (iii) linking models and evaluating their ability to detect and follow changes in terrestrial environments into ecological and economic consequences, and (iv) strengthened Danish research in linking science, modeling and management of the environment and economics and thereby consolidating a strong international position. The DTU Aqua has focused on further development, implementation and validation of advanced models and fisheries and ecosystem management evaluation tools: Development, calibration and implementation of the Baltic ATLANTIS end-to-end ecosystem and tropho-dynamic model linked to the HBM-ERGOM physical and bio-geo-chemical models and the FISHRENT fishery economic model; Further development and implementation of the bio-economic and individual vessel based multi-stock-multi-fleet DISPLACE simulation model; Dynamic coupling of the Baltic FLR multi-stock-multi-fleet bio-economic model to the SMS-Multi-Species model. The focus has been on biological interactions and integrated fisheries interactions.

Partners

The project had 12 project partners mainly from Danish universities (AU, DTU, KU, SDU) and national fisheries economics and fisheries research institutes (SMHI Sweden), but also from American, Swedish and Finnish universities as well as SMEs (e.g. DHI). The project was coordinated by Aarhus University. DTU Aqua was main project developer, WP4 leader and member of the Project Steering Group.

This project was funded by the Danish Council for Strategic Research.
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 international project coordinator; WP1: Review of knowledge: 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 standard survey 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 hydrographic 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 fisheries.

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 as developing advanced scientific survey evaluation models and methods for doing 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.

WP 4 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 area 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.
Monitoring and evaluation of spatially managed areas (MESMA) (38871)

The MESMA project focused on marine spatial planning and aimed to produce integrated management tools (concepts, models and guidelines) for monitoring, evaluating and implementing Spatially Managed Areas (SMAs). The main tasks in the project were information analysis, the development of a generic framework, the testing and evaluation of this framework through case-studies and the development of a toolbox. A significant proportion of the effort was centered on the case studies within five geographical regions: the North Sea, Baltic, Mediterranean, Atlantic, and Black Sea. This approach made it possible to compare pressures on an inter-regional level (e.g. offshore wind farms in the North Sea, Black Sea and Baltic), or a multi-pressure level for a specific region (e.g. SMA in fishing, wind-energy, geo-hazards and tourism in the Black Sea).

The project was coordinated by IMARES, Wageningen UR, The Netherlands.

The project was funded by EU, Framework Programme 7.

National Institute of Aquatic Resources
Section for Ecosystem based Marine Management
Wageningen IMARES
University College London
Senckenberg Gesellschaft für Naturforschung
Ghent University
Hellenic Centre for Marine Research
Bulgarian Academy of Sciences
Institute of Marine Research
University College Cork
National Research Council of Italy
Marine and Food Technological Centre
Polish Academy of Sciences
Ministry for Resources and Rural Affairs
Cefas
Heriot-Watt University
Deltares
Norwegian Institute for Water Research
Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek
Institute for Agricultural and Fisheries Research
Establishment and testing of area-based management models for North Sea sandeel fisheries (ETOMTOBIS) (38588)

The goal of this project is to investigate the effects of area-based management for sandeel stocks and the fisheries. Objectives include developing for optimal area-based management of sandeel fisheries in the North Sea. The tools will first be tested through computer simulations and the experience gained will be used to develop a revised management model at the end of the project. The project will also help fisheries managers to act proactively to other marine management initiatives. In connection with the implementation of the EU Habitat Directive in the North Sea, EU coastal states appoint Natura 2000 areas by 2010. Area based analysis of population dynamics is therefore necessary to quantify the effect of fishing at the local level, and subsequently assess whether fisheries are affecting the habitat. Additional field-based analysis will be valuable in assessing interaction of the sandeel fishery with potential Natura 2000 areas. Spatial management is not only intended to restrict fishing. A description of the consequences for fisheries and sandeel population dynamics are important in assessing the benefits and drawbacks of introducing area-based management of sandeel fisheries in the North Sea. Currently the sandeel fishery is managed under the assumption that there is one population of the sandeel (Ammodytes marinus) in the North Sea, in spite of this, the North Sea sandeel stock can be divided into several sub-populations. Based on recent research there is now a strong wish from ICES (see eg. ICES 2007 and 2008) and from the EU (see eg. STECF 2005), to introduce area based management of the sandeel fisheries, in order to adjust fishing to a level defined as sustainable for each of the local sub-populations. Sandeel stocks in the North Sea will be divided into separate management units, each of which can be regarded as sub-populations who have little or no mutual exchange of both sand eel fry and adult sandeels, as presented in the final report of the project TORTN (project 38128). An assessment model will be developed to analyze sandeel population dynamics for each of the identified management units. A forecast model based on the relevant scientific surveys will predict the actual size of the sandeel recruitment in each of the management areas. Finally a tool will be developed that calculates the catch of sandeels in each of the management areas in a number of scenarios that include output of maximum sustainable yield, the most stable catches, and optimal fisheries management. The project also includes a field sampling module, using two different methods, pelagic larval and demersal 0-group sampling, associated with a tool technological module for this collection to measure the size of the sandeel recruitment. The purpose of the field collection is to continue and analyze existing time series of field data to further develop area based recruitment indices. Field data should also be used as a fishery independent index of the sandeel stock size in the developed assessment model. The project is coordinated by DTU Aqua.
Marine ecosystem evolution in a changing environment (MEECE) (38131)

In order to advance our understanding and the predictive capacities necessary to resolve how marine ecosystems will respond to global change, MEECE employed a combination of data synthesis, numerical simulation, and targeted experimentation to further our knowledge of how marine ecosystems will respond to combinations of these climate change and anthropogenic drivers.

A key objective of MEECE was to advance model coupling across trophic levels and create concepts and infrastructure to enable end-to-end modeling, from physics to fish, which has empirically been difficult due to different space and time scales involved, as well as relative emphasis of statistical and mechanistic aspects. Finally, MEECE integrated modeling advancements with fishery management perspectives.

The project was coordinated by Plymouth Marine Laboratory, UK, and had 21 partners from the EU.

The project was funded by EU, Framework Programme 7.

National Institute of Aquatic Resources

Section for Marine Living Resources
Period: 01/01/2008 → 15/10/2012
Number of participants: 11
Research areas: Marine Living Resources & Marine Populations and Ecosystem Dynamics & Fisheries Management
Acronym: MEECE
Contact person:
Christensen, Asbjørn (Intern)
Project participant:
Vinther, Morten (Intern)
Neuenfeldt, Stefan (Intern)
Mackenzie, Brian (Intern)
Nielsen, J. Rasmus (Intern)
Eero, Margit (Intern)
Andersen, Ken Haste (Intern)
Bastardie, Francois (Intern)
Neumann, Viola (Intern)
Grigorov, Ivo (Intern)
Project Manager, academic:
Köster, Fritz (Intern)

Relations
Publications:
Should “Citizen Scientists” play with climate & ecosystem models?

MyOcean (38134)

The project advanced and coordinated European scientific and technical infrastructure in the European operational oceanography community, for collecting and distributing ocean observations and ocean forecasts. DTU Aqua contributed by developing an integrated system for forecasting of sandeel fisheries in WP3 and in WP18 as reference intermediate user (RIU), for integrating operational oceanography products in marine resource management.

The project was coordinated by Mercator Ocean, France and had 52 partners from the EU.

The project was funded by EU, Framework Programme 7.

National Institute of Aquatic Resources

Section for Marine Living Resources
Period: 01/01/2008 → 15/05/2012
Number of participants: 2
Research areas: Marine Living Resources & Oceanography
Project participant:
Mariani, Patrizio (Intern)
Sustainable fisheries, climate change and the North Sea ecosystem (SUNFISH) (38135)
Global climate changes will seriously challenge the governance of fisheries in the North Sea and elsewhere. Changes in
temperature, wind conditions, river runoff and currents will affect primary and secondary production, the distribution,
feeding, growth and survival of commercially exploited fish at all stages of life. Without improved knowledge about the
effect of climate on the basic biological processes involved in fish production, it will be increasingly difficult to separate the
effects of fishing from those of environmental fluctuations and change, identify biological reference points, and to develop
management strategies for sustainable fisheries. By combining models of the effects of climate on the hydrographical and
biological processes important for fish production with models of fish stock dynamics and fishing, the project provided a
basis for improved predictions of the effects of climate change on the sustainable exploitation and maximum yield of North
Sea fish stocks. The dynamics of cod (a top predator), herring and sandeel (two important prey for fish), seabirds and
marine mammals were studied in detail. Their spawning, egg and larval drift, juvenile and adult distribution, growth and
survival were investigated through experiments, statistical analyses of collected data and advanced bio-oceanographic
models. The sustainability of exploitation under changing climate conditions were examined by modifying an existing
stochastic multispecies fisheries model to make it account for climate effects on fish ecology. The project provided an
integrated modelling framework for developing sustainable fisheries management strategies superior to using simple
extrapolations of observed historical trends to predict the likely outcome of climate change on the North Sea ecosystem.

The project was coordinated by DTU Aqua.

The project was funded by the Danish Council for Strategic Research.
National Institute of Aquatic Resources
Section for Ecosystem based Marine Management
University of Copenhagen
Aarhus University
Danish Meteorological Institute
Marine Scotland

Period: 01/01/2008 → 01/09/2012
Number of participants: 6
Research areas: Ecosystem Based Marine Management & Marine Living Resources

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 (VIIId) 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)
Hüsey, Karin (Intern)
Project

Development and performance test of method for establishing an area based recruitment index for North Sea sandeels
(TORTN) (38128)

The project's overall objective is to establish a recruitment index for sandeel in the North Sea, for use in preparation of the
scientific advice for North Sea sandeel fisheries. It is also an objective that this index should be developed in collaboration
with the fishing industry. This is partly to increase the transparency and credibility of the scientific work but also to reduce
the cost of setting up the necessary information to as low as possible.

It is of significant interest to be able to subdivide North Sea sandeel habitats based on well-founded biological and
physical principles in order to provide spatial explicit stock assessment and advice on local fishing potential. Using
hydrographic modeling and field sampling during the fishing season the coupled larval drift and population model (SPAM)
will be validated.

The North Sea wide collection of winter hibernating sandeels from the seabed with the modified scallop dredges will be
continued and the time series of abundance data will be analyzed. The project will further create a database of VMS, data
corresponding to Danish vessels fishing for sand eels (defined by logbook database). From this data fishing effort, a
fishing ground level will be estimated through the use of VMS and log book data. Using sandeel samples from the fishery
area-based age-length keys will be developed using a continuation logit statistical approach. Combining recruitment data
from population analysis and fisheries independent data on 0-group, the project will further develop, test and optimize a
method for calculating the recruitment of 0-year-old sandeels to the North Sea stock. Real-time Monitoring of the sandeel
fishery, which is the present basis for in season advice on fishing opportunities (applied 2004-2009), earliest establish the
same basis by May i.e. in the middle of the fishing season. The new procedure developed in the project makes it possible
to provide the scientific advice used in fisheries management in January, more than 2 months before the start of fishing
season. Thus the procedure will allow the development of area based recruitment indices to manage the sandeel fishery in
accordance with principles that ensure a more optimal utilization of sandeel stock and also reduces the risk of local
overfishing.

The project is coordinated by DTU Aqua.

National Institute of Aquatic Resources
Section for Marine Living Resources
Modelling the Impact of hydrography and lower trophic production on fish recruitment (MODREC) (38114)
The recruitment of fish stocks is strongly influenced by fluctuations in climate and physical environment leading to strong and seemingly unpredictable year-to-year variations in year class strength. The aim of this project is to develop a model framework for conducting detailed recruitment studies on fish stocks. The framework will be applied for two commercially important fish stocks: sprat and sandeel, in order to improve the understanding of climate effects via bottom-up control and explain the observed high variability in reproductive success in these stocks. The framework will be built on existing hydrographic models by adding descriptions of primary and zooplankton production.

The project is coordinated by DTU Aqua.

National Institute of Aquatic Resources
Section for Marine Ecology and Oceanography
Aarhus University

Resolving climatic impacts on fish stocks (RECLAIM) (38109)
Climate change will impact fisheries resources and challenge managers to develop sustainable exploitation strategies. Knowledge on the impacts of climate on fisheries resources is still fragmentary.

RECLAIM will summarize current knowledge, test process understanding, improve predictive capacity and formulate future research hypotheses by examining trophic processes, geographical distributions and essential habitat requirements for marine and shellfish in the NE-Atlantic.

A conceptual framework will be developed to distinguish between processes acting on individual (physiology, behavior), population (predation, competition) and ecosystem (physical habitat qualities, biological productivity, trophic coupling) levels. The framework structures a literature review to detects gaps in knowledge and, where possible, distinguishes between climate and anthropogenic influences.

A comparative analysis follows quantifying climate variability and changes in distribution and productivity of (i) individual species, (ii) selected fish and shellfish communities, and (iii) ecosystem structure and functioning.

Target species represent different commercially important resources, ecosystem components (pelagics, demersals), and play key trophic roles (wasp-waist, apex predators) within NE-Atlantic ecosystems.

Changes in ecosystem structure and functioning will be analyzed from fisheries and scientific survey data including planktonic, benthic and fish production and consumption in relation to climate forcing and fishing. Relevant spatial and temporal scales of climate change and variability will be explored using time series analyses, spatial statistics and coupled 3-D hydrodynamic ecosystem models.
Using a variety of approaches, RECLAIM will both hind cast as well as forecast the effects of climate change on the productivity and distribution of fish and shellfish stocks to formulate hypotheses and research needs to be addressed in future EU research.

The project is coordinated by IMARES, The Netherlands, and has nine partners from the EU.

National Institute of Aquatic Resources

Section for Marine Ecology and Oceanography
Period: 01/01/2007 → 31/12/2009
Number of participants: 12
Research area: Marine Populations and Ecosystem Dynamics
Contact person:
Christensen, Asbjørn (Intern)
Project participant:
Neuenfeldt, Stefan (Intern)
MacKenzie, Brian (Intern)
Andersen, Ken Haste (Intern)
Huwer, Bastian (Intern)
Payne, Mark (Intern)
Brander, Keith (Intern)
Gürkan, Zeren (Intern)
Mosegaard, Henrik (Intern)
Geitner, Kerstin (Intern)
Jensen, Henrik (Ekstern)
Project Manager, academic:
Köster, Fritz (Intern)

Bank resolved prognoses of sandeel fishing potential in the North Sea (38563)
Sandeel stocks in the North Sea have experienced successive recruitment failures within the last 5 years. There is an urgent need to develop management tools that may contribute near and long term planning of the sandeel fishery and understand the reasons behind recent recruitment failures.

The project has three main goals:
(i) To fill some of the current knowledge gaps in the biology of North Sea sandeels and evaluate the North Sea sandeel stock via monitoring programs;
(ii) To demonstrate by combining advanced modelling with biological knowledge, that it is possible to generate fishing potential prognoses for sandeel spatially resolved at bank levels, just like ubiquitous whether forecasts, which at sight may be incorporated in the fishery management process;
(iii) To develop the collaboration with the Danish Fishermen's Association (DF) and foster a sustainable sandeel fishery based on increased self regulation within the fishery.

The scientific activities in this project relate developing the necessary components, which are a premise for generating fishing potential forecasts. This encompasses computer model code writing and data collection. The efforts have been very successful and a first generation fishing potential forecast has been generated as final products of this project. On the modelling side two model components has been developed. The first is the larval module that describes hydrodynamical transport of sandeel larvae which is determining next year's recruitment. The second component is the population model which combines the hydrodynamical transport output with available biological data and knowledge into a spatially explicit sandeel stock model. Two fishing vessels take part in the project.

The project is coordinated by DTU Aqua.

National Institute of Aquatic Resources

Section for Marine Living Resources

Danish Meteorological Institute

Danish Fishermen's Association
Period: 01/01/2005 → 31/12/2007
Number of participants: 3
Research area: Marine Living Resources
Project participant:
Marine protected areas as a tool for ecosystem conservation and fisheries management (PROTECT) (38095)

1) To evaluate the potential of MPAs as a tool to protect sensitive species, habitats and ecosystems from the effect of fishing.

2) To outline and develop monitoring, assessment and management tools for MPAs that can assess: a) the impact of fisheries on marine ecosystems, b) the effect of different levels of protection and c) the impact and socio-economic effects of MPAs on fishing communities.

3) To facilitate linkages between science and management in the areas of: a) MPA design and implementation, b) timing and level of stakeholder involvement and c) management effectiveness and adaptability.

The project was coordinated by DTU Aqua.

National Institute of Aquatic Resources
Section for Ecosystem based Marine Management
Finnish Game and Fisheries Research Institute
Swedish National Board of Fisheries
Institute for Marine Sciences
University of Hamburg
Sea Fisheries Institute
Centre for Ecology and Hydrology
Cefas
Marine Scotland
National University of Ireland
Institute of Marine Research
University of Portsmouth
University of Tromsø
IFREMER
University of Gothenburg
Wageningen IMARES
University of Copenhagen

Period: 01/01/2005 → 31/12/2008
Number of participants: 9
Research area: Ecosystem Based Marine Management

Contact person:
Nielsen, J. Rasmus (Intern)
Project participant:
Christensen, Asbjørn (Intern)
Sørensen, Thomas Kirk (Intern)
Project Manager, academic:
Hoffmann, Erik (Intern)
Mosegaard, Henrik (Intern)
Vestergaard, Ole (Ekstern)
Jensen, Henrik (Ekstern)
Kraus, Gerd (Ekstern)
Møllmann, Christian (Ekstern)

Project

**Critical interactions between species and their implications for a precautionary fisheries management in a variable environment – a modeling approach (BECAUSE) (38613)**

Across Europe, the population of predatory fish has fallen dramatically in recent years. This has reduced the predation rate and the prey species has remained fairly stable. Therefore the balance between predators and prey species has been radically changed. No accurate scientific picture of the exact interactions between these species and their effects on non-commercial top predators is available. To maintain biodiversity and make recovery plans more effective, such an understanding is vital.

The sustainable management of European fisheries requires an adaptive approach that takes into account the long term dynamics of the entire marine ecosystem so as to protect the biodiversity of our seas. BECAUSE investigated the interaction between predator and prey, and the shifts in their relative populations and looked into how fishing affects the balance of the marine food chain. The interactions targeted for investigation included sandeel/predator fish, predators and prey of cod, and hake/prey fish.

Contributions to the policy development aimed at integrating a sustainable ecosystem approach into the EU’s Common Fisheries Policy (CFP) thereby helping the EU to meet its global fishing commitments and underwrite the sustainability of ecosystem services. Multi-species fisheries assessment were improved and enhanced policy and management measures to replenish fish stocks and ensure high yields were proposed.

The was coordinated by Universität Hamburg, Germany.

**National Institute of Aquatic Resources**

**Section for Marine Ecology and Oceanography**

**Universität Hamburg**

**Marine and Food Technological Centre**

**Cefas**

**Finnish Game and Fisheries Research Institute**

**Marine Scotland**

**Marine Research Institute**

**Leibniz Institute of Marine Sciences**

**IFREMER**

**Consejo Superior de Investigaciones Científicas**

**Institute of Marine Research**

**National Centre for Marine Research**

**Sea Fisheries Institute**

**Sapienza University of Rome**

**University of St Andrews**

**Latvian Fish Resources Agency**

**Instituto Español de Oceanografía**

**Period: 01/01/2004 → 31/12/2007**

**Number of participants: 6**

**Research area: Marine Living Resources**

**Contact person:**

Köster, Fritz (Intern)

**Project participant:**

Tomkiewicz, Jonna (Intern)

Neuenfeldt, Stefan (Intern)

Rindorf, Anna (Intern)

Christensen, Asbjørn (Intern)

**Project Manager, organisational:**
Analysis of biological key parameters, population structure and population dynamics of the lesser sandeel (Ammodytes marinus) in the North Sea, based on detailed information about the sandeel fishery (AHA.DOT) (2167)

The overall goal is to establish the scientific basis for a management system for the North Sea sandeel fishery that will prevent local depletion of sandeels due to fishing and improve the yield of the fishery.

Stock assessment of sandeels in the North Sea is based on the assumption that there is one stock of sandeels in the North Sea and one stock in the Shetland area. However, recent investigations suggest that sandeels in the North Sea can be divided into several stock components or sub-stocks. Further, growth and fecundity seem to vary significantly between the different stock components. This project will analyse spatial trends in key biological parameters (emergence behaviour, growth and fecundity) and the distribution of the lesser sandeel Ammodytes marinus in the North Sea. Additionally the drift pattern of sandeels larvae between the spawning areas will be analysed by use of a hydrographical model. Information about distribution, biological parameters and the drift of larvae will be used to define the stock components of sandeels to be assessed as separate population units.

Besides the lack of information about the spatial heterogeneity on the biology of sandeels, the possibility to carry out regional assessments is hindered by a lack of information about the sandeel fishery and the catches of sandeels, where the main problem being the level of aggregation of the data. To carry out assessments for each of the stock components separately, more detailed information about the fishery and the catches of sandeels is needed. The data available about the fishery can only be allocated to ICES rectangles. However, data will have to be allocated to fishing grounds. Effort and catch data as well as biological samples has since 1999 been collected on a by haul basis for 15-20 Danish vessels representing the existing vessel categories and fishing pattern in the Danish North Sea sandeel fishery. During this project satellite data for all Danish vessels fishing sandeels in the North Sea will together with the detailed data from the 15-20 vessels, be used to disaggregate data on effort and catches of sandeels, from being on a trip and ICES rectangle level to being on a haul and fishing ground level.

The information about the biology and population structure of sandeels and the detailed data about catches and effort will be used to carry out separate assessments of each of the stock components of sandeels. Furthermore, a model that was developed at DTU Aqua (THEMAS) will be used to simulate the effect of different management scenarios on the fishing fleet and the sandeel populations.

The project was coordinated by DTU Aqua.

National Institute of Aquatic Resources
Section for Marine Living Resources
Danish Fishermen's Association
Krog Consult ApS
University of Hamburg
Marine Scotland Science
Perdod: 01/01/2003 → 31/12/2007
Number of participants: 4
Research area: Marine Living Resources
Project Manager, academic:
Mosegaard, Henrik (Intern)
Rindorf, Anna (Intern)
Christensen, Asbjørn (Intern)
Jensen, Henrik (Ekstern)

Interatomare vekselvirkninger i metaller.

Department of Physics
Period: 01/09/1993 → 27/01/1997
Number of participants: 3
Phd Student:
Christensen, Asbjørn (Intern)
Supervisor:
Jacobsen, Karsten Wedel (Intern)
Main Supervisor:
Nørskov, Jens Kehlet (Intern)

Financing sources
Activities:

ICES - Working Group on Fisheries-Induced Evolution - WGEVO (External organisation)
Period: 2012 → ...
Asbjørn Christensen (Participant)
National Institute of Aquatic Resources
Section for Population Ecology and Genetics
Degree of recognition: International

Related external organisation

ICES - Working Group on Integrative, Physical-biological, and Ecosystem Modelling - WGIPEM (External organisation)
Period: 2012 → ...
Asbjørn Christensen (Participant)
National Institute of Aquatic Resources
Section for Population Ecology and Genetics
Degree of recognition: International

Related external organisation

ICES - Working Group on Integrative, Physical-biological, and Ecosystem Modelling - WGIPEM
Activity: Membership › Membership of committees, commissions, boards, councils, associations, organisations, or similar