Maintaining a sustainable sprat fishery in the North Sea (BEBRIS) (39548)
The aim of the project is to support the maintenance of a sustainable sprat fishery in the North Sea, Skagerrak and Kattegat; a fishery of great importance to the Danish industrial fishery. In the project we will be working with the stock assessment model and forecast models (as preparation for the ICES sprat benchmark). In order to support the development of a long-term management, a generic Management Strategy Evaluation tool will be developed according to ICES guidelines. The project will also analyse the role of weather conditions on catchability and distribution of catches. Lastly, the project will look into the possibility of using the IBTS Q3 survey to develop a recruitment index. The project also include scientist-stakeholder collaboration and participation in international meetings.

The project is coordinated by DTU Aqua and is funded by the European Maritime and Fisheries Fund and the Danish Fisheries Agency.

van Deurs, M., Project Coordinator, National Institute of Aquatic Resources, Section for Marine Living Resources
Huwer, B., Project Participant, National Institute of Aquatic Resources
Munk, P., Project Participant, National Institute of Aquatic Resources
Lindgren, M., Project Participant, National Institute of Aquatic Resources
Rindorf, A., Project Participant, National Institute of Aquatic Resources
Brooks, M. E., PI, National Institute of Aquatic Resources
01/06/2018 → 30/12/2020
Keywords: Research area: Marine Populations and Ecosystem Dynamics
Project: Research

Validating age-determination of anglerfish and hake: an exploratory investigation using microchemistry analysis (39498)
The estimation of the biological reference points used in fish stock assessment requires reliable length-at-age information which is usually obtained by counting and measuring seasonal growth marks in otoliths for a representative sample of the population.

However, for some stocks, clearly defined growth marks do not occur, hampering age estimation and age based assessment and presenting a challenge to the implementation of MSY based management as required under the CFP. For the stocks of anglerfishes (Lophius spp.) and hake (Merluccius merluccius) that are the focus of this tender the reliability of available age-estimation methods is low and the estimation of MSY reference points is problematic. For these stocks, improved growth models are needed to inform length based assessments.

The specified objective of this tender is to analyse microchemistry patterns in otoliths and illicia with the intention of developing improved growth models to inform length-based assessments for the hake and anglerfish stocks of interest.

This proposal addresses that objective by combining the reanalysis of previously collected microchemistry data with additional analyses of existing and newly collected material and a comprehensive analysis of length distributions from available survey data. For hake, direct validation of seasonal microchemistry patterns is possible using existing collections of chemically tagged otoliths. For anglerfish, seasonality will be confirmed using marginal microchemistry analysis of quarterly collections. Pairwise comparisons of otoliths and illicia will allow us to establish the extent to which growth marks and opacity profiles in each structure correspond to seasonal trends in microchemistry.

The tender is funded by EASME/EMFF/2017/012 and is coordinated by Galway Mayo Institute of Technology, Ireland.
Hüssy, K., Project Manager, National Institute of Aquatic Resources, Section for Oceans and Arctic
01/01/2018 → 13/12/2019
Keywords: Research area: Marine Populations and Ecosystem Dynamics
Collaborators: Galway - Mayo Institute of Technology, Marine Institute, CSIC (Spain), University of Bergen, IFREMER
Project: Research

Mechanistic approach to ocean ecology (39427)
The overarching goal of the proposed research is to develop a mechanistically underpinned, trait-based model of marine plankton ecosystems ranging across multiple trophic levels from bacteria to zooplankton. The rationale and methods and rooted in the trait-based approach developed by the Centre for Ocean Life. Zooplankton has a key role in the model, and the themes guiding model design are trait biogeography (i.e., spatio-temporal distributions of traits) and vertical material fluxes and carbon sequestration.

The work will be organized in four interlinked work packages (WPs), each guided by a particular research question. All models will be implemented in a physical setting, and WPs 1-3 represent an increasing degree of complexity from unicellular plankton in a 0D environment toward a full size-based model in 2D environment. WP1 and 2 develop the unicellular and multicellular components, WP3 the full size based model, and WP4 sets up the model for the California Current system and tests the model against field observations collected by the Zooglider and through the CalCOFI monitoring program.

The project is coordinated by DTU Aqua.
The project is funded by Gordon and Betty Moore Foundation.
Development of management models for fish stocks (39415)
The aim of the project is to support the ongoing process of developing long-term management plans for short-lived species of great importance to the Danish fishery and to maintain the international position of Danish fisheries research.

The project contains the following objectives: (1) provide a data-driven basis for developing an alternative management model for sandeel in the North Sea, (2) Evaluate a portfolio of management strategies for short-lived species in the North Sea, and (3) contribute with new data to the ICES multi-species model that provide natural mortality estimates to be used in single-species stock assessment models and in relation to an ongoing international effort to take on a holistic ecosystem approach to management.

The project also include scientist-stakeholder collaboration and participation in international meeting in EU and ICES.

The project is coordinated by DTU Aqua and funded by the European Maritime and Fisheries Fund and the Danish Fisheries Agency.

Project: Research

Arctic impact on weather and climate (Blue-Action) (39390)
Blue-Action will provide fundamental and empirically-grounded, executable science that quantifies and explains the role of a changing Arctic in increasing predictive capability of weather and climate of the Northern Hemisphere. To achieve this Blue-Action will take a transdisciplinary approach, bridging scientific understanding within Arctic climate, weather and risk management research, with key stakeholder knowledge of the impacts of climatic weather extremes and hazardous events; leading to the co-design of better services. This bridge will build on innovative statistical and dynamical approaches to predict weather and climate extremes. In dialogue with users, Blue-Action will take stock in existing knowledge about cross-sectoral impacts and vulnerabilities with respect to the occurrence of these events when associated to weather and climate predictions. Modeling and prediction capabilities will be enhanced by targeting firstly, lower latitude oceanic and atmospheric drivers of regional Arctic changes and secondly, Arctic impacts on Northern Hemisphere climate and weather extremes. Coordinated multi-model experiments will be key to test new higher resolution model configurations, innovative methods to reduce forecast error, and advanced methods to improve uptake of new Earth observations assets are planned. Blue-Action thereby demonstrates how such an uptake may assist in creating better optimized observation system for various modelling applications. The improved robust and reliable forecasting can help meteorological and climate services to better deliver tailored predictions and advice, including sub-seasonal to seasonal time scales, will take Arctic climate prediction beyond seasons and to teleconnections over the Northern Hemisphere. Blue-Action will through its concerted efforts therefore contribute to the improvement of climate models to represent Arctic warming realistically and address its impact on regional and global atmospheric and oceanic circulation.

The project is coordinated by DMI, Denmark and is funded by EU Horizon 2020 Programme Blue Growth.

Project: Research
Brown shrimp fishery in the North Sea (39418)
The purpose of the project is to improve the possibilities for evaluating the self-management of the brown shrimp fishery and develop this through analysis of the impact of management actions on the brown shrimp stock. This objective is to be met in three work packages. Through improved monitoring and survey design (AP2) as well as model based analysis of brown shrimp dynamics and the mechanisms of stock fluctuations (AP1 and AP3) in order to calculate stock development and a number of associated parameters for current and future self-management and thereby increase opportunities for an optimal sustainable fishery on the resource.

The project further aims to build the national preparedness for advice provision on issues concerning the brown shrimp fishery. Some of the main contributions will be in preparation for international survey participation and operational stock modelling (AP3). The project will also set up systems for future fisher – researcher collaboration in management of brown shrimp fisheries and contribute to the increase and facilitating of international scientific cooperation on brown shrimp fishing through enhanced active Danish participation in relevant fora (AP4).

The project will thus
(1) collate all available information about the biology of brown shrimp and its function in the ecosystem in an easily accessible form, for the benefit of fisheries and management.
(2) Design, implement and analyse an optimized monitoring and survey system that can support stock analyses and management decisions.
(3) Analyse brown shrimp population distribution and fluctuations, and in combination with controlled growth and reproduction experiments clarify the key parameters that determine population dynamics.
(4) Develop a stock assessment model based on DTU Aquas statistical modelling framework, which, based on available data, can estimate stock development and provide the basis for international management advice.
(5) Through the results, provide input to international advisory work in ICES and STECF.

The long-term impact of the project will be a scientific contribution to sustainable self-management and utilization of an economically important resource for local fisheries.

This project is funded by the European Maritime Fisheries Fund and the Danish Fisheries Agency.

This project is coordinated by DTU Aqua.

Mosegaard, H., Project Coordinator, National Institute of Aquatic Resources, Section for Marine Living Resources
Pedersen, E. M., Project Participant, National Institute of Aquatic Resources
Stage, B., Project Participant, National Institute of Aquatic Resources
Krekoukiotis, D., Project Participant, National Institute of Aquatic Resources
Andreasen, H., Project Participant, National Institute of Aquatic Resources
Behrens, J., Project Participant, National Institute of Aquatic Resources
Petersen, J. K., Project Participant, National Institute of Aquatic Resources
Veicherts, M., Project Participant
van Deurs, M., Project Participant, National Institute of Aquatic Resources
Andersen, N. G., Project Participant, National Institute of Aquatic Resources
Nielsen, P., Project Participant, National Institute of Aquatic Resources

14/09/2016 → 13/12/2018

Keywords: Research areas: Marine Populations and Ecosystem Dynamics & Marine Living Resources

Collaborators: Danish Fishermen's Association

Project: Research

Distribution of mackerel, herring and sprat (MAKSIBRI) (39434)
The overarching objective of the project is to increase knowledge about the spatial distribution of populations of herring, sprat and mackerel in the North Sea, Skagerrak and Kattegat. Application of new genetic marker based analyses has proven especially useful in this context and the project aims to apply newly developed markers in herring and sprat. In mackerel, the distribution of stock components in the North Sea will be examined using existing material and data. For herring, focus is on validating genetic and morphological methods and testing them to assess samples of herring bycatch from the sprat fishery. In sprat focus is on determining population components in the North Sea and Skagerrak using both genetic and modeling other types of biological data.

The project is coordinated by DTU Aqua and is funded by the European Maritime and Fisheries Fund (EMFF) and the Danish Fisheries Agency.

Bekkevold, D., Project Coordinator, National Institute of Aquatic Resources, Section for Marine Living Resources
Mosegaard, H., Project Participant, National Institute of Aquatic Resources
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.

The project is is coordinated by DTU Aqua and is funded by the European Maritime and Fisheries Fund (EMFF) and the Danish Fisheries Agency.

Climate Change and European Aquatic Resources (CERES) (39344)
CERES advances a cause-and-effect understanding of how climate change will influence Europe's most important fish and shellfish resources and the economic activities depending on them. It will provide tools and develop adaptive strategies allowing fisheries and aquaculture sectors and their governance to anticipate and prepare for adverse changes or future benefits of climate change.

The project has 24 additional partners spread across Europe and is coordinated by University of Hamburg, Germany. The project is funded by EU, Horizon 2020.

Process integration into multispecies and ecosystem models: Resulting ecological, economic and social trade offs (PRIME TRADE OFFS) (39324)
Extensive multispecies and ecosystem research has been done in the Baltic, North Sea, Barents Sea/Norwegian Sea, Bay of Biscay and the Black Sea in the past about 30 years. There has been invested substantially in the research on multispecies interactions, and ecosystem functioning.

In parallel, significant knowledge on the environmental impacts on recruitment processes, movements or migrations, and species interactions has been accumulated, but not yet consequently integrated in multispecies and ecosystem models and management concepts.

The major questions raised in PRIME TRADE OFFS are hence, (i) how the integration of environmentally-driven variability in population and ecosystem dynamics affects short- and long-term predictions of economically important fish species, and (ii) how the inclusion of environmental variability changes our perceptions of tradeoffs between utilization of different resources, including for example fuel cost due to changed resource distributions in space and effects on targeted species,
as well as socio-economic efficiency.

There have been several initiatives to improve multispecies and ecosystem modelling in order to make it operational for both tactical and strategic assessment and ecosystem-based fisheries management. PRIME TRADEOFFS is the logical continuation of these initiatives and will make the concepts of multi-species maximum sustainable yield and environmental impact on biological key process such as distribution, growth and recruitment operational for ecosystem-based management of marine resources, as demanded in the Marine Strategy Framework Directive and the reformed Common Fisheries Policy.

This project is coordinated by DTU Aqua and is funded by the EU, COFASP, ERA-NET.

Neuenfeldt, S., Project Coordinator, National Institute of Aquatic Resources, Section for Oceans and Arctic
Andersen, N. G., Project Participant, National Institute of Aquatic Resources
Mariani, P., Project Participant, National Institute of Aquatic Resources
Thygesen, U. H., Project Participant, National Institute of Aquatic Resources
01/03/2016 → 28/02/2019

Keywords: Research areas: Marine Populations and Ecosystem Dynamics & Oceanography & Fisheries Management
Collaborators: AZTI Technalia, Institute of Marine Research, University of Hamburg, IFREMER
Project: Research

Tagging Baltic cod (TABACOD) (39333)
The aim of this project is to improve the management of eastern Baltic cod by 1) providing new information on growth and mortality patterns, and 2) develop a validated method for deriving this information from historic and future samples. In recent years, the traditional age-based stock assessment had to be abandoned owing to extensive uncertainties in stock trends. These uncertainties were to a large extent attributable to inconsistencies in age estimation. As a consequence thereof, the current stock status is unknown.

Estimates of growth and mortality rely on unbiased age information. TABACOD will provide this information through a large scale tagging experiment, where 20,000 cod are tagged with an externally visible tag as well as an internal tag on their otoliths. This experiment will also provide the samples for the development and validation of a new age estimation method based on the chemical composition of the cod's otoliths.

The knowledge gained will be incorporated in length-based assessment models and their performance compared to the traditional methods evaluated in order to provide the ICES stock assessment group with the relevant tools to provide a reliable advice and to improve stock exploitation.

This project is coordinated by DTU Aqua.
The project is funded by BalticSea2020.

Hüssy, K., Project Coordinator, National Institute of Aquatic Resources, Section for Oceans and Arctic
Olesen, H. J., Project Participant, National Institute of Aquatic Resources
Andersen, N. G., Project Participant, National Institute of Aquatic Resources
Storr-Paulsen, M., Project Participant, National Institute of Aquatic Resources
Thygesen, U. H., Project Participant, National Institute of Aquatic Resources
Berg, C. W., Project Participant, National Institute of Aquatic Resources
Nielsen, K. E., PhD Student, National Institute of Aquatic Resources
01/01/2016 → 31/12/2019

Keywords: Research areas: Marine Populations and Ecosystem Dynamics & Fish Biology & Marine Living Resources
Collaborators: Swedish University of Agricultural Sciences, National Marine Fisheries Research Institute, Thunen-Institut
Project: Research

Collaborative modular underwater robotic system for long-term autonomous operations (REMORA) (39341)
In this project we aim to bootstrap new high-impact underwater robotics activities at DTU. We propose to develop a novel robotic platform, the REMORA1 system, for research, education and innovation. The objectives of the project are to develop the necessary infrastructure, i.e., underwater robotic system, test facilities, educational framework and external collaboration, to perform world-class research and innovation in the area of offshore underwater robotic technology.

With this project we aim to eventually strengthen the Danish maritime sector in dealing with the high cost and technical challenges of inspections and maintenance in increasing amount of offshore installations. The project is a collaboration between DTU Electrical Engineering, DTU Mechanical Engineering and DTU Aqua who have complementary expertise within development and innovation of robotic technology and applications of underwater robotics.

This project is coordinated by DTU Electrical Engineering.
The project is funded by A/S Dampskibsselskabet Orients Fond.

Mariani, P., Project Participant, National Institute of Aquatic Resources
Visser, A., Project Participant, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography
01/12/2015 → 21/12/2017

Keywords: Research areas: Oceanography & Observation Technology & Marine Populations and Ecosystem Dynamics
Collaborators: Technical University of Denmark
Project: Research

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 implicate 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.

The project is coordinated by DTU Aqua and is funded by the European Maritime and Fisheries Fund (EMFF) and the Danish Fisheries Agency.

Worsøe Clausen, L., Project Coordinator, National Institute of Aquatic Resources, Section for Marine Living Resources
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Mosegaard, H., Project Participant, National Institute of Aquatic Resources
Bekkevold, D., Project Participant, National Institute of Aquatic Resources
Mortensen, L. O., Project Participant, National Institute of Aquatic Resources
Christensen, A., Project Participant, National Institute of Aquatic Resources

11/11/2015 → 17/08/2018

Keywords: Research areas: Marine Living Resources & Population Genetics & Fish Biology & Marine Populations and Ecosystem Dynamics & Fisheries Management & Ecosystem based Marine Management
Collaborators: Danish Fisherman's Association, Danish Pelagic Producers Organisation, Marine Ingredients Denmark
Project: Research

Marine management of ecosystem dynamics under climate change (MARmaED) (39300)
MARmaED is an EU Initial Training Network that unifies specific and complementary competences in marine sciences from Norway, Finland, Denmark, the Netherlands, Germany and France to investigate how the cumulative stress from biodiversity loss, climate change and harvesting will affect Europe’s complex marine systems and the consequences for optimal resource management. MARmaED incorporates feedbacks between the socioeconomic and the ecological systems that give rise to critical transitions.

This project is coordinated by University of Oslo, Norway.
The project is funded by EU, Marie Curie.
Andersen, K. H., Project Manager, National Institute of Aquatic Resources, Centre for Ocean Life
Lindegren, M., Project Participant, National Institute of Aquatic Resources
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Beukhof, E. D., PhD Student, National Institute of Aquatic Resources

01/10/2015 → 01/10/2019

Keywords: Research area: Marine Populations and Ecosystem Dynamics
Collaborators: University of Bergen, University of Oslo, Météo-France, University of Helsinki, Åbo Akademi University, Wageningen University & Research, University of Hamburg
Project: Research

BONUS BIO-C3 Cruise (39117-DCH)
The multidisciplinary research cruise (16-30 September 2015) was aiming to investigate the distribution, abundance, biomass, production, nutritional condition and genetic diversity of several, trophically interlinked Baltic key species, ranging from zoo-, and ichthyoplankton over gelatinous organisms to adult fish, including non-indigenous species. The collected samples and data are used in the BONUS project Biodiversity changes—causes, consequences and management implications (BIO-C3), aiming to significantly advance our knowledge base towards the importance and management of the Baltic Sea biodiversity in an ecosystem perspective.

Using the contrasting environments of the Arkona, Bornholm, Gdansk and Gotland Basin, the major scientific goals of the cruise have been to resolve:
- Physiological preferences and tolerances of key meso-zooplankton species (Pseudocalanus acuspes, Temora longicornis, Centropages hamatus and Acartia spp), through controlled experiments on board with specimens caught in different areas of the central Baltic in contrasting environments, including a verification of species based on genetics,
- Abundance, distribution, nutritional condition and phenology of key zooplankton (see above) and their life stages as well as gelatinous plankton species ( Aurelia aurita, Cyanea capillata, Mertensia ovum, Mnemiopsis leidyi) in different areas of the central Baltic, through net-sampling and deploying hydroacoustics and optics, as well as biochemical analyses,
- Individual condition, abundance and distribution of spawning herring and cod based on trawl sampling and hydroacoustics including biochemical investigations on the quality of spawning products,
- Abundance and survival of herring and cod ichthyoplankton, through net-sampling based stage specific production
estimates, including age determination, nutritional condition and growth in relation to abundance, phenology and composition of zooplankton prey,
- Predation pressure on copepods and fish early life stages by herring and sprat as well as gelatinous plankton (see above) through resolving the spatial overlap between predator and prey at relevant scales as well as diet composition analyses,
- Distribution (vertical and horizontal) of sprat and herring through trawl sampling and hydroacoustics in relation to hydrography, zooplankton prey and predator (cod) abundance, with specific focus on growth, condition and survival of young of the year sprat in different areas of the central Baltic.
This project was coordinated by DTU Aqua.
The project was funded by Danish Center for Marine Research.
Köster, F., Project Coordinator, National Institute of Aquatic Resources
Huwer, B., Project Manager, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography
Tomkiewicz, J., Project Manager, National Institute of Aquatic Resources
Lundgren, B., Project Participant, National Institute of Aquatic Resources, Arctic Section
Krüger-Johnsen, M., Project Participant, National Institute of Aquatic Resources
Neumann, V., PhD Student, National Institute of Aquatic Resources
16/09/2015 → 30/09/2015
Keywords: Research areas: Marine Populations and Ecosystem Dynamics & Fish Biology
Collaborators: Leibniz Institute for Baltic Sea Research, National Marine Fisheries Research Institute, GEOMAR - Helmholtz Centre for Ocean Research Kiel, University of Tartu, University of Hamburg, Thunen-Institut
Project: Research

Environmental neutral aquaculture water treatment (MIVANAK) (39295)
Despite a transition from flow-through systems to more advanced open water reuse aquaculture systems (e.g. model trout farms), the need for water treatment still exists. In brackish and saltwater reuse systems, blooms of toxic microalgae can be an example of a recently new challenge.
The purpose of this project is to further develop current aquaculture water treatment practice and reduce the total amount of disinfectants used.
The project includes 3 different work packages, investigating
- ecological consequences of continuous application of peroxyacetic acid.
- toxicological effects of easy degradable disinfectants.
- alternative biological methods to control / avoid blooms of toxic heterotrophic dinoflagellates.
Trials will include mesocosmos experiments where disinfectants are added continuously or by daily pulses over a prolonged period of time where phyto- and zoo-plankton abundance and compositions will be investigated. Other trials will be made in batch experiments with pure algae cultures, as well prolonged continuous peroxyacid application experiments be made.
This project is coordinated by DTU Aqua.
The project is funded by the Environmental Protection Agency's Programme for Pesticide Research.
Pedersen, L., Project Manager, National Institute of Aquatic Resources, Section for Aquaculture
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Koski, M., Project Participant, National Institute of Aquatic Resources
Rojas-Tirado, P. A., PhD Student, National Institute of Aquatic Resources
Sprogøl, U., Project Participant, National Institute of Aquatic Resources
Frandsen, D., Project Participant, National Institute of Aquatic Resources
Møller, B., Project Participant, National Institute of Aquatic Resources
Larsen, O. M., Project Participant, National Institute of Aquatic Resources
Jensen, R. F., Project Participant, National Institute of Aquatic Resources
01/08/2015 → 31/12/2017
Keywords: Research areas: Aquaculture & Marine Populations and Ecosystem Dynamics
Project: Research

A systems approach framework for coastal research and management in the Baltic (BaltCoast) (39201)
The ultimate objective of this project is a coherent and systematic management approach that encompasses multiple impacts in a spatially heterogeneous context.
In BaltCoast we tackle this complex task using the Systems Approach Framework (SAF). The SAF is an issue oriented investigation and methodology that applies a holistic perspective. It investigates and quantifies the functions of systems in order to simulate specific questions concerning their functions or policies. It comprises the process from issue identification through system analyses to policy implementation.
This Systems Approach can, hence, competently address implementation of international directives (e.g. Water Framework Directive (WFD), Marine Strategy Framework Directive (MSFD)). In BaltCoast we address multiple issues through case studies that reflect current regional management challenges and develop a generic tool for integrated system assessment.
This project is coordinated by Leibniz-Institute for Baltic Sea Research (IOW).
The project is funded by EU, BONUS (Science for a Better Future of the Baltic Sea Region), ERA-NET, Statetrup, J. G., Contact Person, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Intelligent oceanographically-based short-term fishery forecasting applications (GOFORIT) (39270)

Fisheries for short lived species are highly variable because they primarily target a low number of age groups within stocks as well as irregularly recruiting year-classes. As a result, environmental fluctuations (e.g., temperature, food abundance), which cause major changes in fish productivity, can lead to rapid fluctuations in fishing opportunities and stock declines if fishing effort is not reduced accordingly. Such fluctuations are not foreseen or accommodated by management advisory frameworks for short-lived species, which generally assume environmental stability and constant productivity. The GOFORIT project will use climatic and oceanographic process knowledge with the goal to improve short-term fishery forecasts.

The project is coordinated by DTU Aqua.

Funding
The project is funded by EU, COFASP, ERA-NET.

Keywords: Research areas: Oceanography & Marine Populations and Ecosystem Dynamics & Marine Living Resources & Ecosystem based Marine Management

Collaborators: National Institute for Marine Research and Development, Marine Research Institute Reykjavik, Institute of Marine Sciences, Central Fisheries Research Institute

Project: Research

Dynamic user-driven marine e-maps for the advancement of Danish industrial fisheries (GUPD-VIND) (39248)

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.

Fishermen 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).

Keywords: Research areas: Coastal Ecology & Marine Populations and Ecosystem Dynamics & Marine Living Resources & Ecosystem based Marine Management

Collaborators: Swedish University of Agricultural Sciences, Leibniz Institute for Baltic Sea Research, Klaipeda University, University of Latvia, Tallinn University, Polish Academy of Sciences

Project: Research
Ecophysiology of great feasts in nature
The project investigated the ecophysiology of the great feasts in nature, exemplified by cod in the sound that feasts on migrating herring in fall.
The project was coordinated by DTU Aqua.
The project was funded by the Danish Council for Independent Research.

Round goby – need for collaborative science and management in Nordic and Baltic countries (39171)
Originating from the Ponto-Caspian region, the round goby Neogobius melanostomus has within recent years proliferated in several Nordic and Baltic coastal waters. Round goby is now not only posing a threat to native goby species occupying similar habitats, but also to the traditional coastal fishery through competition for food resources with commercially and recreationally important coastal species, and consumption of their fry and eggs. Furthermore, fishermen report on declined shrimp catches, one of the preferred prey items of adult round goby.
The overarching aim of this project is to have a common Nordic and Baltic workshop on round goby. This will enable knowledge transfer across borders, identification of knowledge gaps and creating wide research projects on issues related to round goby invasion. Equally important, it would provide an opportunity to inform relevant authorities on the challenges of managing the species and to develop instruments to mitigate the impact on native coastal species and fisheries.
Outcome of the workshop will be a report on the current distribution and status of round goby in the Nordic/Baltic countries that could be used for future risk analyses and basis for management decisions, indicating future needs.
The project is coordinated by DTU Aqua.
Integrating spatial processes into ecosystem models for sustainable utilization of fish resources (INSPIRE) (39118)

The BONUS INSPIRE Project conducts pilot ecosystem field surveys that help resolving the habitat requirements of different life stages of the focal species by combined use of traditional methods and application of modern advanced analysis and modelling techniques. The research is conducted in a matrix approach with four species specific case (cod, herring, sprat and flounder) and five research work-packages. The work packages deal with (i) habitat requirements and survival probability for different life stages, (ii) connectivity between habitat occupied in successive life stages, (iii) spatial scaling from local events to regional population dynamics, (iv) spatially explicit analytical stock assessments (including a comprehensive flatfish programme), and (v) ecosystem-based management and Marine Strategy Framework Directive indicators.

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

This project is coordinated by University of Tartu, Estonia.

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

The early life of eel in the Sargasso Sea – Influence of oceanography and climate (SARGASSO-EEL) (39107)

The recruitment of the European eel has been in dramatic decline during the last 30 years, and is at a severe low of only 3-5% of earlier magnitude. This change and its influence on the eel fishery have led to an intensified research in the oceanic phase of the European eel.

In order to contribute to further understanding of the life cycle of eel the Danish eel expedition set out in 2014 for the eel spawning grounds in the Sargasso Sea. Here a consortium of Danish scientists and international collaborators focused on the linkages between oceanography, biological production, eel spawning and the growth and drift of eel larvae. During the expedition, a wide range of organisms was collected: From the smallest plankton of less than a millimeter to very large fish. A number of research groups are now working on samples and data from the expedition and assembling information on key processes in the early life of eels. Preliminary findings indicate that biological and physical changes have taken place in the spawning areas that may affect the eel larvae’s chances of survival and their journey to Europe.

The project was coordinated by DTU Aqua.

The project is funded by the Carlsberg Foundation and Danish Centre of Marine Research (cruise).
Optimal sustainable use of cod stocks accessible for Danish fisheries (DEL-TORSK) (39147)
Optimal sustainable utilization of cod stocks that contain several biological sub-populations requires taking population structure into account in stock assessment and management. The aim of this project was to develop scientific basis for cod management decisions in the North Sea and the Baltic that takes biological units of cod and their dynamics into account.
Methodological challenges concerning advising on stocks that contain sub-populations with differences in dynamics and biological parameters are common for North Sea and the Baltic. Therefore, the project considered both seas, in terms of developing methodological basis for addressing population structure in management advice. The results were presented at ICES benchmarks for North Sea and Baltic Sea cod in 2015, and used to developing further the management basis for optimal use of cod stocks.
The project included mapping of distribution of sub-populations using genetic analyses and modelling of transport of early life stages. These results were combined with existing knowledge on cod population structure both in the Baltic and North Sea, to identify distribution areas of sub populations. This information was then incorporated in area-specific stock assessment analyses.
This project was coordinated by DTU Aqua.
The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).
Eero, M., Project Coordinator, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Hansen, J. H., Project Participant, National Institute of Aquatic Resources
Mariani, P., Project Participant, National Institute of Aquatic Resources
Berg, C. W., Project Participant, National Institute of Aquatic Resources
Hüssy, K., Project Participant, National Institute of Aquatic Resources
Huwer, B., Project Participant, National Institute of Aquatic Resources
Nielsen, A., Project Participant, National Institute of Aquatic Resources
Eg Nielsen, E., Project Participant, National Institute of Aquatic Resources
17/07/2013 → 30/04/2015
Keywords: Research areas: Ecosystem based Marine Management & Marine Populations and Ecosystem Dynamics & Population Genetics & Fish Biology & Marine Living Resources & Fisheries Management
Project: Research

Changes in marine resources in Skagerrak and Kattegat 1946-2012 – Catch and revenue in the post war fishery and transformation of the fleet (DIGIFISH) (39103)
The project has compiled catch and economic data from fisheries in Skagerrak and Kattegat since 1946. The aim of the project was to establish a common database for future utilization in the research of development of fisheries and socio-economics in the specific area.
Research institutes from Sweden (Swedish University of Agricultural Sciences), Norway (Oxford Research) and Denmark (DTU Aqua) participated in the project. Data has been extracted from various national statistical databases and logbooks/landing slips from the fishery. The output from the project is a database with landings and economic values of fish landed in Skagerrak and Kattegat, comprising all commercial species and thereby valuable for historic studies of the species and their utilization.
There is a pressure from consumers on the fishing industry to legitimate sustainability in the fisheries, which normally requires assessments and advice consistent with international criteria on sustainability. A prerequisite for such an approach is complete catch data back in time. Therefore, the present project provides important data to base assessments on and to perspective recent fisheries with historic data.
Economic data in the database will enable socio-economic analyses of the different fisheries, including changes on structure of society and fishery.
This project was coordinated by DTU Aqua.
The project was funded by the AG Fisk (Working Group for Fisheries), Nordic Council of Ministers.
Boje, J., Project Participant, National Institute of Aquatic Resources, Arctic Section
01/01/2013 → 31/12/2013
Marine litter in Nordic waters (MANOFA) (39104)

"Marine litter in the Nordic waters" was a project funded by The Marine Group (HAV) under The Nordic Council of Ministers in 2013-2014. The main aim of the project was to establish a Nordic forum for collaboration and exchange of knowledge on status for methodologies and available data for marine litter between Nordic experts, environmental managers and stakeholders, due to the common environmental concerns in our shared seas. Among other activities, the project compiled information that can be used as a contribution to facilitate the framing of this environmental problem in a Nordic perspective. Two workshops were held about I) Common knowledge status on marine litter in the Nordic countries, and indicators relevant for EU Marine Strategy Framework Directive (14 November 2013 in Gothenburg, Sweden) and II) Status for monitoring and Future actions (6-7 November 2014 in Oslo, Norway).

The project was coordinated by Aarhus University.

The project was funded by Nordforsk, Nordic Council of Ministers.

Sørensen, T. K., Project Manager, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management

Andreasen, H., Project Participant, National Institute of Aquatic Resources

01/01/2013 → 31/12/2014

Sustainable technologies to control microalgae in land based saltwater recirculating systems (39032)

Land based salt water recirculating systems is a potential alternative to fish farming in net pens. This purpose of this project was to test different solutions on how to control unwanted microalgae growth thereby addressing a potential challenges associated with land based farming.

A high degree of water reuse and the associated nutrient accumulation may favour growth of microorganisms and thereby deteriorate the biological water quality.

The project included:
- Test of improved mechanical filtration (application of pilot scale protein skimmers on small to medium sized RAS, and application of full scale 4 meter vacuum airlift; an innovative treatment technique tested in full scale RAS)
- Test of chemical water treatment routines using easy degradable disinfectants (Peracetic acid, chloramine-T, hydrogen peroxide) to control and inhibit toxic microalgae,
- Test of electrochemical oxidation disinfection technology to assess the efficacy (radical formation and algicidal effects) of boron doped diamond electrodes.

Numerous batch and pilot scale experiments were made at the section for Aquaculture, Hirtshals. In addition, intensive, diurnal sampling/monitoring and analysis on location was performed on a commercial pike perch RAS facilities facing toxic algae problems.

The project is coordinated by DTU Aqua.

The project was funded by the National Environmental Protection Agency through Programme for Development and Demonstration of Bio-technologies (MUDP).

Pedersen, L., Project Coordinator, National Institute of Aquatic Resources

Pedersen, P. B., Project Participant, National Institute of Aquatic Resources

Sproegel, U., Project Participant, National Institute of Aquatic Resources

Frandsen, D., Project Participant, National Institute of Aquatic Resources

Møller, B., Project Participant, National Institute of Aquatic Resources

Larsen, O. M., Project Participant, National Institute of Aquatic Resources

Jensen, R. F., Project Participant, National Institute of Aquatic Resources

01/01/2013 → 30/11/2013

Study on stomach content of fish to support the assessment of good environmental status of marine food webs and the prediction of MSY after stock restoration (Open call for tenders No MARE/2012/02) (39036)

In support of policies for sustainable management strategies of living marine resources, demands for integrated ecosystem advice are growing and more extensive use of long-term management plans, which are consistent with the ecosystem approach to fisheries management, is anticipated. However, long-term management plan evaluations of fish are particularly sensitive to changes in the proportion of fish removed by natural predators (natural mortality). A prerequisite for estimating this correctly is accurate knowledge of species interactions: Who is eating whom when, where
Existing stomach content data are currently used in multispecies models using historic stomach content data from before 1995. Since this period, there have been considerable changes in the predator and prey stocks of both the Baltic and the North Sea. Thus, updated information on stomach contents of the essential predators in these two areas is urgently needed.

In order to update and improve the quality and quantity of the available background data for the above mentioned multispecies models and management plans, the aim of this project is to
- conduct new stomach content analyses of Baltic cod to support our knowledge of the spatial and temporal stability of cod preferences
- conduct new stomach content analyses of Baltic whiting as well as grey gurnard, mackerel and hake collected in the North Sea to support our knowledge of potentially important predators for which the diet is presently poorly known or is expected to have changed significantly since the last sampling efforts
- compile historical data, which are existing in several institutes around the Baltic and North Sea, and convert them from paper or outdated electronic format into the necessary standard format
- incorporate the new as well as all appropriate historical stomach content information into the Baltic and North Sea stomach content databases

The end product will be updated stomach content databases for the Baltic and North Sea, which include all available information up to 2013. In the Baltic, the project will increase the number of stomachs available for modeling by more than 170%. In the North Sea, the project will increase the number of years where data are available for grey gurnard from 2 to 8, for mackerel from 2 to 6 and for hake from 0 to 1, hence substantially increasing the confidence in the temporal stability of the modeling results.

The databases will be made freely available to the scientific community and will form the basis for new estimates of natural mortality and improved long-term management plans in the Baltic and North Sea.

The project is coordinated by DTU Aqua.
Huwer, B., Project Coordinator, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography
Andreasen, H., Project Participant, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography
Neuenfeldt, S., Project Participant, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography
Rindorf, A., Project Participant, National Institute of Aquatic Resources
Storr-Pauleen, M., Project Participant, National Institute of Aquatic Resources
Andersen, N. G., Project Participant, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography
Haslund, O. H., Project Manager, National Institute of Aquatic Resources
27/11/2012 → 27/11/2014
Keywords: Research area: Marine Populations and Ecosystem Dynamics
Collaborators: Lund University, Wageningen IMARES, National Marine Fisheries Research Institute, Thunen-Institut, Institute of Food Safety Animal Health and Environment BIOR, University of Hamburg, Cefas Weymouth Laboratory
Project: Research

**Investigation of causes for declines in fish abundance in coastal areas (KYSTFISK 1) (39031)**
Danish fishermen complained of drastic declines in coastal fish populations, negatively impacting their fisheries opportunities but the nature and magnitude of the problem was uncertain. This project aimed to collate information from fishers to map the problem, including which species and geographical areas involved. In total 74 fishers were interviewed and the problem mapped in Støttrup et al. (2014a). The project further aimed to explore existing survey data that could support the observed changes in fish distribution (Støttrup et al. 2014b) and conduct a literature review to explore if similar trends had occurred in neighboring countries and potential causes for the developments had been identified (Dutz et al. in revision).

The project is coordinated by DTU Aqua and funded by the Danish Ministry of Food, Agriculture and Fisheries and the
North Atlantic climate (NACLIM) (38945)
The North Atlantic Ocean is one of the most important drivers for the global ocean circulation and its variability on time scales beyond inter-annual. Global climate variability is to a large extent triggered by changes in the North Atlantic sea surface state. The quality and skill of climate predictions depends crucially on a good knowledge of the northern sea surface temperatures (SST) and sea ice distributions. On a regional scale, these parameters strongly impact on weather and climate in Europe, determining precipitation patterns and strengths, as well as changes in temperature and wind patterns. Knowledge of these factors, and of their development in the years to come, is of paramount importance for society and key economic sectors, which have to base their planning and decisions on robust climate information. NACLIM will contribute to this goal.

DTU Aqua is the leader of work package developing such climate services for marine ecosystems, pioneering the translation of decadal-scale forecasts of the ocean’s physical environment to forecasts of the biological environment. There are 18 project partners in total. See http://naclim.zmaw.de/Consortium.2126.0.html
The project is coordinated by University of Hamburg, Germany.
The project is funded by EU, Framework Programme 7.
Payne, M., Project Manager, Section for Marine Ecology and Oceanography, National Institute of Aquatic Resources, Section for Oceans and Arctic
MacKenzie, B., Project Participant, National Institute of Aquatic Resources
Miesner, A. K., PhD Student, National Institute of Aquatic Resources
01/11/2012 → 31/01/2017
Keywords: Research areas: Marine Populations and Ecosystem Dynamics & Oceanography
Project: Research

Assessing and improving the quality of aquatic animal gametes to enhance aquatic resources – The need to harmonize and standardize evolving methodologies and improve transfer from academia to industry (AQUAGAMETE) (39130)
The aim of the AQUAGAMETE COST Action is to reach a consensus on protocols and guidelines (using internationally defined terminology, units of measurement and format of reporting) that permit the use of results in relational databanks.
for sound and common application in aquaculture research and commerce. There is an urgent need towards a universal scale to assess both the precise state of sexual maturation (for secure broodstock use) and related life history traits (gamete quality assessment, incubation of eggs) in teleost fish and other commercially important invertebrates used in either bioassays or aquaculture.

During the past six years, three international workshops on fish gametes demonstrated a rapid development of methodologies that encompass extensive opportunities for promising use in basic reproductive biology, genetic research, biotechnology and aquaculture practice. All of these can have far-reaching consequences on conservation of endangered species, assessment of anthropogenic and climatic impacts on aquatic species and application in aquaculture, as well as in fisheries management. In particular, it has been recognized that there are many highly diverging details in the practical application of these new methods used by most scientists and laboratories, which can cause highly variable if not contradicting results, even using the same species.

COST action management and scientific activities comprise meetings, congresses and workshops, training schools and short term training mission (STSM) program. The action has funded participation of delegates Jonna Tomkiewicz and Ian A.E. Butts in action management meetings and three AQUAGAMETE conferences, participation of two students in training schools, six short term missions (STSM) of MSC and PhD students performing work at the labs of international collaborators as well as their participation in AQUAGAMETE conferences. Exchange of students and collaboration has resulted in a series of publications enhanced through collaboration as well as enriched learning by students through international networking.

Other partners than DTU Aqua (countries and number of institutes): Austria (1), Belgium (1), Bulgaria (2), Croatia (1), Czech Republic (1), Finland (3), France (3), Macedonia (1), Germany (1), Greece (4), Hungary (1), Israel (2), Italy (2), Netherlands (1), Norway (1), Poland (2), Portugal (1), Serbia (1), Slovenia (2), Spain (10), Sweden (2), Turkey (2), UK (2), International Partner Countries (IPC): Brazil, Japan (1), Singapore, South Africa (1).

AQUAGAMETE is funded by COST, EU (European Cooperation in Science and Technology).

Tomkiewicz, J., Project Participant, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography
Butts, I., Project Participant, National Institute of Aquatic Resources

01/01/2012 → 31/12/2016

Keywords: Research areas: Fish Biology & Marine Populations and Ecosystem Dynamics
Project: Research

Center for Ocean Life (COOL) - a Villum-Kahn Rasmussen Centre of excellence for the study of life in a changing ocean (38960)

Our goal is to develop a fundamental understanding and predictive capability of marine ecosystems through the use of novel trait-based approaches and models.

The Centre is organized around three main research activities:
- Identification and mechanistic description of the traits and trade-offs required to characterize the main Darwinian missions (feed, survive, reproduce) of the various life forms in the ocean through experimental and theoretical work, as well as analysis of literature data.
- Models: scaling of individual behavior to population and ecosystem dynamics through the development of trait-based models.
- Testing model prediction by comparing to observed trait patterns in the ocean.

The Centre involves biologists, physicist, chemists, and mathematicians and has a very strong training component through the supervision of master students, and about 30 PhD and postdoctoral fellows as well as by offering PhD summer schools and organizing international workshops. The Centre in addition host many visiting students and scientists. The Centre is lead by DTU Aqua.

The project is funded by the Villum Kahn-Rasmussen Foundation (Velux Foundations) as well as through various national and European fellowship programs (Research Council, H.C. Ørsted Fellowship programme, Marie Curie, Carlsberg Foundation, etc).

Kiørboe, T., Project Manager, National Institute of Aquatic Resources, Centre for Ocean Life
Andersen, K. H., Project Participant, National Institute of Aquatic Resources
Visser, A., Project Participant, National Institute of Aquatic Resources
Stedmon, C., Project Participant, National Institute of Aquatic Resources
Gislason, H., Project Participant, National Institute of Aquatic Resources
Payne, M., Project Participant, National Institute of Aquatic Resources
Thygesen, U. H., Project Participant, National Institute of Aquatic Resources
MacKenzie, B., Project Participant, National Institute of Aquatic Resources
Mariani, P., Project Participant, National Institute of Aquatic Resources
Nielsen, T. G., Project Participant, National Institute of Aquatic Resources

01/01/2012 → 31/12/2017

Keywords: Research areas: Oceanography & Marine Populations and Ecosystem Dynamics & Marine Living Resources & Ecosystem based Marine Management
Collaborators: Michigan State University, University of Bergen, Kiel University, University of Copenhagen, Massachusetts Institute of Technology, University of Oxford, Roskilde University
Project: Research
Cruise with RV Dana. North Atlantic-Arctic Ocean Coupling: Deep water overflows and surface water outflow (NAAO) (38928)

This cruise was planned as an essential part of the Danish contribution to oceanographic fieldwork as part of the NAACOS project (2011-2014), funded by the Strategic Research Council.

The main objectives of the cruise were to obtain a comprehensive suite of physical, chemical and biological oceanographic measurements across the East Greenland shelf, extending into the Greenland Sea, and to study the deep-water overflow in the Denmark Strait.

The data collected on this cruise formed the basis of validating and improving circulation and ecological models in the region and developing new approaches to tracing freshwater and organic carbon exported from the Arctic.

The project was funded by the Danish Center for Marine Research.

Stedmon, C., Project Coordinator, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography
Jonasdottir, S., Project Participant, National Institute of Aquatic Resources
01/01/2012 → 31/12/2012

Keywords: Research areas: Oceanography & Marine Populations and Ecosystem Dynamics
Collaborators: Aarhus University, University of Copenhagen, Greenland Institute of Natural Resources
Project: Research

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 suitablefor implementation in operational centers.

In order to advance our understanding andpredictive 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, oxygen 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 acommonality 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.

Chistensen, A., Project Manager, National Institute of Aquatic Resources, Section for Marine Living Resources
Vinther, M., Project Participant, National Institute of Aquatic Resources
Neuenfeldt, S., Project Participant, National Institute of Aquatic Resources
St. John, M., Project Participant, National Institute of Aquatic Resources
01/01/2012 → 31/12/2014

Keywords: Research areas: Marine Living Resources & Marine Populations and Ecosystem Dynamics & Ecosystem based Marine Management
Project: Research

Eastern-western Baltic cod: Improved management based on stock discrimination of eastern and western Baltic cod (Øst-Vesttorsk) (38989)

The aim of this project was to improve the management of western Baltic cod by incorporating stock identification routines in order to discriminate between eastern and western Baltic cod stocks.

In recent years evidence from fishery patterns and otolith structures have indicated an increasing degree of mixing between the two cod stocks which up until 2013 were managed as two separate stocks. Changes in fishing pressure and patterns would therefore result in a risk for local depletion of the smaller western stock.

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

The project was coordinated by Centre for Environment, Fisheries & Aquaculture Science, UK.

The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).
The whole is an intricate weave of interrelated mechanisms: the scientific challenge to earth’s albedo is one feedback, but there is also the drawdown and sequestering of atmospheric CO2 in deep waters by the world. More subtle still are the feedback controls these processes have on climate change. Sea-ice coverage and the formation, deep water circulation, and freshwater supply on a relatively local scale will have repercussions around the world.

The North Atlantic and Arctic Ocean are the headwaters of the thermohaline circulation (THC), the global heat engine. These changes have profound effects both at the regional scale as well as globally. Climate change is most pronounced at high latitudes, with rapid and dramatic changes observed in sea-ice coverage, compositions, sizes and distributions of animals that lived in the ocean during periods with less human impact than today, and how eutrophication has affected forage fish production in the Baltic Sea. Ongoing work is evaluating and documenting the causes of long-term declines of a local herring population in the Baltic Sea and swordfish fisheries in coastal New England, Nova Scotia and Italy. Another key result is a recent consensus article by an ICES expert group on how historical ecology can contribute to fisheries and ecosystem management. Because HMAP and CoML have ended, DTU Aqua’s work in this area continues with support from other projects and as contributions to new successor fora established in 2013-2015. These include the Oceans Past Initiative, ICES Study Group on the History of Fish and Fisheries and the EU COST program Oceans Past Platform (2015). DTU Aqua’s work will contribute to the development of new management and conservation policies by demonstrating the species compositions, sizes and distributions of animals that lived in the ocean during periods with less human impact than today, and how these biological properties have changed over time.

The project was coordinated by Trinity College, Ireland. The project was funded by Trinity College, Dublin, Ireland. MacKenzie, B., Contact Person, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography

History of marine animal populations (HMAP) (38156)
The History of Marine Animal Populations (HMAP) is the historical component of the Census of Marine Life program (CoML), which is an international, multi-disciplinary project which will investigate biodiversity in the world’s oceans. HMAP’s long-term aim is to improve our historical understanding of ecosystem change and our ecological understanding of man’s role in changing marine ecosystems. The long data series and time-specific snapshots of marine ecological conditions that are being generated are being used to provide input to contemporary ecological modelling in order to characterize and visualize variations in past ecosystems. Such visualizations and testing of ecological hypotheses will enhance the disciplines of history and ecology in seeking to explain long-term changes in marine animal populations and their ecosystems, especially those changes resulting from man’s activities.

Some key results from our earlier historical ecology work include reconstructions of extended time series of cod and sprat biomasses in the Baltic Sea which have enabled us to document how the relative importance of different ecosystem drivers (e.g., fishing, hydrographic variability, mammal predation, eutrophication) of biomass dynamics change and interact over time, and how eutrophication has affected forage fish production in the Baltic Sea. Ongoing work is evaluating and documenting the causes of long-term declines of a local herring population in the Baltic Sea and swordfish fisheries in coastal New England, Nova Scotia and Italy. Another key result is a recent consensus article by an ICES expert group on how historical ecology can contribute to fisheries and ecosystem management.

Because HMAP and CoML have ended, DTU Aqua’s work in this area continues with support from other projects and as contributions to new successor fora established in 2013-2015. These include the Oceans Past Initiative, ICES Study Group on the History of Fish and Fisheries and the EU COST program Oceans Past Platform (2015). DTU Aqua’s work will contribute to the development of new management and conservation policies by demonstrating the species compositions, sizes and distributions of animals that lived in the ocean during periods with less human impact than today, and how these biological properties have changed over time.

The project was coordinated by Trinity College, Ireland. The project was funded by Trinity College, Dublin, Ireland. MacKenzie, B., Contact Person, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography

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.

Visser, A., Project Manager, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography
Stedmon, C., Project Participant, National Institute of Aquatic Resources
Koski, M., Project Participant, National Institute of Aquatic Resources
Mariani, P., Project Participant, National Institute of Aquatic Resources
Christensen, A., Project Participant, National Institute of Aquatic Resources
Jonasdottir, S., Project Participant, National Institute of Aquatic Resources

Keywords: Research areas: Oceanography & Marine Populations and Ecosystem Dynamics & Marine Living Resources
Collaborators: Aarhus University, Danish Meteorological Institute, DHI Water - Environment - Health, University of Copenhagen, Faroe Research Institute
Project: Research

**Trait based plankton ecology (38896)**

Plankton is the dominating life-form in the ocean. It is mainly invisible and lives in a viscous world that is not part of our sensed experience. As a consequence, important properties of life in the oceans remain poorly understood. This project has aimed to further a cross-disciplinary research activity to promote an understanding of the dynamics of marine pelagic ecosystems that is based on mechanistic descriptions of the functioning of and interaction between its individuals. We provided trait-based descriptions of the key functions of plankton, formulate their associated trade-offs, and develop trait-based models of plankton ecosystem that we will test against observations.

The core activity of the project was the development of mechanistic descriptions of key plankton traits and their trade-offs and development of trait-based models of pelagic systems. The immediate goal of the project was to achieve fundamental insights in the functioning of pelagic ecosystems but ultimately the models to examine effects of environmental changes and human impact. The project was a ‘precursor’ for the Centre for Ocean Life.

The project was coordinated by DTU Aqua.

The project was funded by the Danish Council for Independent Research.

Kiørboe, T., Project Manager, National Institute of Aquatic Resources, Centre for Ocean Life
Andersen, K. H., Project Participant, National Institute of Aquatic Resources
Nielsen, T. G., Project Participant, National Institute of Aquatic Resources
Thygesen, U. H., Project Participant, National Institute of Aquatic Resources
Mariani, P., Project Participant, National Institute of Aquatic Resources

Keywords: Research areas: Oceanography & Marine Populations and Ecosystem Dynamics
Collaborators: Aarhus University, Roskilde University
Project: Research

**Arctic plankton in a changing climate (38783)**

Climate change impacts the marine arctic environment through changes in ice cover, ice thickness, irradiance, freshwater outflow, concentrations of nutrients and CO2 and the stratification. These factors determine the production, seasonality and fate of the planktonic primary production in the marine ecosystem. Plankton is fueling stocks of fish, marine birds and mammals and through that constitutes the base of the Greenlandic economy.

The aim of the project was to gain knowledge about the interaction between climate, oceanography and plankton in the vulnerable Greenlandic marine ecosystem trough field and laboratory experiments. The project was interdisciplinary and closely coordinated with the other projects under the Greenland Climate Research Centre.

The project was funded by the Commission for Scientific Investigations in Greenland (KVUG), Greenland Climate Research Centre, Danish Centre for Marine Research, and Carlsberg Foundation.

The project was coordinated by DTU Aqua.

Nielsen, T. G., Project Manager, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography
Jonasdottir, S., Project Participant, National Institute of Aquatic Resources
Koski, M., Project Participant, National Institute of Aquatic Resources
Dutz, J., Project Participant, National Institute of Aquatic Resources
Kjellerup, S., Project Participant, National Institute of Aquatic Resources
Swalethorp, R., Project Participant, National Institute of Aquatic Resources
Munk, P., Project Participant, National Institute of Aquatic Resources

Keywords: Research areas: Oceanography & Marine Populations and Ecosystem Dynamics
Collaborators: Aarhus University, Greenland Institute of Natural Resources
Project: Research
The project was funded by the Danish National Research Foundation.
The project was coordinated by University of Copenhagen, Denmark.

Key results by DTU Aqua colleagues in the project include the following:
- A pan-Atlantic analysis and discovery of how temperature affects reproductive timing in cod, with evidence for local adaptation of cod thermal physiology and counter-gradient evolution. Our ongoing work is now investigating the consequences of this adaptation for match-mismatch of cod larval production with the timing of the peak production of major zooplankton prey species (e.g., Calanus finmarchicus, Pseudocalanus sp.).
- New estimates of the numbers, locations and volumes of the mesopelagic provinces of the world’s oceans, and based for the first time on the dynamics of ocean primary productivity, C sedimentation and photic zones. These new habitat descriptors of the mesopelagic ocean will provide new contexts for studies of ocean biodiversity, and the distribution and productivity of mesopelagic fishes and other biota.
- New models of fish lifetime reproductive output which demonstrated that a fish’s annual reproductive output was strongly related to maximum body size. Moreover, indeterminate spawners had ca. 10-fold higher reproductive output per unit weight than determinate spawners suggesting possible differences in survival rates among the early life history stages between these two groups of fishes.
- Estimates of how climate change will affect the spawning locations and timing for herring in the North Sea, based on climate change scenarios, lab studies of temperature effects on egg survival rate and substrate requirements for herring egg deposition.
- Global patterns in taxonomic and functional descriptors of fish biodiversity and how these are inter-related and affected by ocean conditions (e.g., primary production, ecosystem size). Ongoing work is relating these patterns to biodiversity protection (e.g., MPA coverage).

The project was coordinated by University of Copenhagen, Denmark.
The project was funded by the Danish National Research Foundation.

Collaborators: University of Copenhagen

Keywords: Research areas: Oceanography & Marine Populations and Ecosystem Dynamics

Project: Research
Forage fish interactions (FACTS) (38781)
Removal of a forage fish has consequences for both predators and prey of forage fish. As everything is connected, every management action has a price which goes beyond the apparent, direct effect on the target species. The fishery on forage fish can therefore not be seen in isolation, as the immediate gain in profit from the fishery has to be discounted by the lowered potential for production of large piscivorous fish. Management actions on other species also influences forage fish, i.e. conservation efforts on marine mammals or sea birds have direct consequences for the predation pressure on forage fish.

The objective of the project was to provide insight and quantitative advice on the ecosystem wide consequences of management actions directly or indirectly related to forage fish.

The two overarching questions were:
- What are the consequences of forage fish fisheries on (a) predator growth and abundance, (b) economic output of fisheries on piscivorous species, and (c) ecosystem stability and the risk for regime shifts?
- What are the consequences of changes in predator populations on forage fish populations and fisheries?

The method was a combination of ecosystem models, of process studies aimed at feeding into the models, of economic models, and of data-analysis of existing data sources.

The project covered four ecosystems in detail: Norwegian-Barents Sea, Baltic Sea, North Sea and Bay of Biscay.

FACTS brought together leading European fisheries and university institutes working on creating the tools for ecosystem based management. The active involvement of the institutes in the current management has provided a means for the results of the project to feed into management. The project furthermore included a network component which has ensured a wider dissemination of methods and results within the marine scientific community.

The project was coordinated by DTU Aqua.

The project was funded by EU, Framework Programme 7.

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

The REX project showed that changes in the biomass densities of cod differ between bottom types (and may depend on stock size) and the proportion of the cod population found on smooth bottoms is not constant. However, due to scaling problems and too short a time series the achieved results have so far had no impact on the assessment procedure or any (measurable) effect on the TAC’s (but the RAC discussions may have affected decisions by the European Commission).

Continuation of the field work with the trawler in 2010-12 in the RESOURCE project should produce a sufficient time series for supplementing the abundance indices for the older ages in the assessment, which at present are based only on the catch rates in the international scientific surveys (IBTS). This total REX-RESOURCE time series will be used in the state
space assessment of North Sea cod (SAM) and various other approaches applied to document how commercial CPUE may be used in the tuning procedure. Particular attention will be given to evaluate the size of the spawning stock of cod.

Mechanistic knowledge on vital rates together with REX, RESOURCE, OSKAR and IBTS (and possibly also UK) survey data will be used as input to the geostatistical tool GeoPop to estimate the temporal and spatial dynamics of the size distribution of the cod stock. This part of the project will represent a direct continuation of OSKAR principles including considerations to how to design an operational fishery-forecast system for North Sea cod.

The project is coordinated by DTU Aqua.
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Hüssy, K., Project Participant, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography
Kristensen, K., Project Participant, National Institute of Aquatic Resources
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Mosegaard, H., Project Participant, National Institute of Aquatic Resources
Christensen, A., Project Participant, National Institute of Aquatic Resources
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01/01/2010 → 30/09/2012
Keywords: Research area: Marine Populations and Ecosystem Dynamics
Collaborators: Danish Fishermen's Association
Project: Research

Monitoring and modelling vertical movements of Greenland halibut in Disko Bay (38795)
The project measured and parameterized Greenland halibut behaviour in terms of vertical movement patterns by means of data storage tags. The tags were released (and recaptured) prior to the project period under another project, so that data was available at start of the project.
Previous measurements using Data Storage tags on halibut tagged in Disko Bay have shown that the halibut undertake distinct vertical migrations of several hundred meters at a time during a few hours.
The findings in the project from analyses of the previous tagging’s gave important biological information on the seasonal migration patterns for Greenland halibut in the West Greenland Fjords; icefjords are mainly preferred as wintering habitat for the fish while the outer parts of the fjord systems are summer habitats. Further, the study showed that halibut are fast vertical swimmers most likely when chasing pelagic prey fishes.
The project was coordinated by DTU Aqua.
The project was funded by the Commission for Scientific Investigations in Greenland (KVUG).
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01/01/2010 → 31/12/2013
Keywords: Research areas: Marine Populations and Ecosystem Dynamics & Fish Biology
Collaborators: Greenland Institute of Natural Resources
Project: Research

Reproduction of European eel: Towards a self-sustained aquaculture (PRO-EEL) (38793)
Reproduction of European eel (Anguilla anguilla) in culture has become a research priority area due a severe decline of natural stocks and an increasing interest to breed eels for a self-sustained aquaculture. As eels do not reproduce naturally in captivity, development of methodology and technology was needed for production of viable eggs and larvae from broodstock in a regular and predictable way.
Focus of PRO-EEL project was on the primary bottlenecks in a controlled reproduction of eels, which concern deficiencies in knowledge about eel reproductive physiology and methods applied to induce and finalize gamete development. During a 4-year period, the project significantly expanded current knowledge on the eel reproductive mechanisms and hormonal control of sexual maturation. The consortium developed standardized protocols for assisted production of high quality gametes (egg and sperm) and artificial fertilization, thereby obtaining a stable production of viable embryos. Furthermore, egg incubation procedures and culture of yolksac larvae were established for the first time for European eel, leading to the first feeding stage. The project disseminated novel literature on early life stages, including their ontogeny and requirements thereby describing egg and larval stages still unknown in nature and providing important information for future development of larval diets and rearing technology. Methodology and technology was established using small scale
The Baltic Sea is subject to several major human impacts, and three of the most important are fishing, eutrophication and climate change. Understanding and projecting how these impacts will affect the food web and its fish populations in future is therefore challenging, and requires modelling approaches which include climatic-hydrographic forcing, nutrient loading scenarios and likely fishing intensities.

ECOSUPPORT was a project whose objective was to develop an advanced modelling tool for conducting scenario simulations of how these human impacts affect the marine ecosystem and fish populations. The project coupled several different types of models so that end-to-end ecosystem models were developed which to understand how human impacts could influence the Baltic food web and fish populations. The models to be linked included regional climate models, oceanographic-lower trophic level ecosystem models (Nutrient-Phytoplankton-Zooplankton-Detritus) and fish population models. Key project results included new scenario simulations how regionally downscaled global climate model outputs would affect the development of Baltic cod populations under scenarios of climate change and seal (predator) population growth, and under different combinations of eutrophication, exploitation and climate change. These simulations included all key elements of the foodweb via an Ecopath model which included competitive and predatory interactions between the major fish species in the Baltic. The results demonstrated the vulnerability of the cod population to successful implementation of key ecosystem management policies for the Baltic Sea, including those related to exploitation and nutrient loading. Additional model scenarios focused on the sprat population which is a key intermediary link in the Baltic foodweb as prey and predator for cod and of zooplankton. These scenarios illustrated the range of future biomass and yields under assumed ranges of climate change and natural mortality.

One of the major novelties of the project was the availability of 3 different NPZD models, which enable estimation of output uncertainties to different model parameterizations and assumptions in the lower trophic levels and physical oceanographic processes, and to compare these with uncertainties due to fish population dynamics (e.g., recruitment variability). These comparisons suggest that the biological uncertainty associated with fish population dynamics was larger than that associated with the choice of the oceanographic NPZD model.

Partners in the project are the above mentioned and five other marine research institutes around the Baltic Sea. The project is coordinated by DTU Aqua.

The project was funded by EU, Framework Programme 7.

Collaborators: Leiden University, Wageningen IMARES, University of Copenhagen, Demokritos National Centre for Scientific Research, Billund Aquaculture Service Aps, National Institute of Sciences and Technologies of the Sea, Norwegian University of Science and Technology, BioMar A/S, Institute of Marine Research, Polytechnic University of Valencia, National Institute for Agronomic Research, Nofima, Ghent University

Project: Research

Advanced modelling tool for scenarios of the Baltic Sea ecosystem to support decision making (ECOSUPPORT) (38733)

The project was an international, EU-funded research project characterized by an integrative and multidisciplinary approach. The consortium brought together leading experts in eel reproduction complemented by expertise in disciplines filling gaps in knowledge and technology. The consortium included 15 partners, comprising European research institutes and industry partners as well as an international collaboration partner country (ICPC). Within DTU, the project involved DTU Food, Research Group for Bioactives – Analysis and Application, and several DTU Aqua research areas including Fish Biology, Aquaculture, Marine Populations and Ecosystem Dynamics, and Coastal Ecology.

The project was coordinated by DTU Aqua.

The project was funded by EU, Framework Programme 7.

Collaborators: Leibniz Institute for Baltic Sea Research, Stockholm University, GKSS-Research Centre, University of Gothenburg, Swedish Meteorological and Hydrological Institute

Project: Research
Cardio-respiratory adaptations in cod feeding under hypoxic conditions (CarlsbergTorsk) (38851)
Employment of DataStorage Tags on individual Atlantic cod (Gadus morhua) in the Bornholm Basin has shown that some fish migrate towards the deeper basin centre, presumably to feed. During these voluntary dives, fish expose themselves to oxygen saturations as low as 10% and many individuals spend a third of their total time at oxygen saturation.

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01/01/2009 → 31/05/2012
Keywords: Research areas: Marine Populations and Ecosystem Dynamics & Fish Biology & Marine Living Resources
Collaborators: University of Gothenburg
Project: Research

Developing fisheries management indicators and targets (DEFINEIT) (38763)
DEFINEIT constructed operational models of fish stock dynamics explicitly taking into account exploitation and climatic conditions and combine these models with basic economic models. To ensure an outstanding scientific level in each of these areas, the project brought together key competences in operational multispecies modelling, stock recruitment relationships, population dynamics of non-target fish species and economic modelling of fisheries from a wide geographic area ranging from the Barents Sea to the North Sea. The project used multispecies models to investigate changes in predation induced by differences in the distribution and the amount of alternative food. Effects of technical interactions in the fishing process were considered to avoid delivering management advice for different stocks which is mutually inconsistent. Integrating the knowledge gained, the project suggested methods for estimating reference points. The project identified the main causes of variation in recruitment patterns between stocks as well as the key processes from spawning to recruitment of selected stocks. The consequences of using proxies to describe stock reproductive potential were determined and survival during early life stages was investigated in order to identify the role of the physical and biological environment. The improved understanding of recruitment variability was used in individual stock assessment and included in multispecies models to provide reliable predictions. The maximum level of fishing effort consistent with sustainment of susceptible species was estimated along with the effect of discard of by-catch on economic yield. The project developed resource indicators that combine economic, social and biological indicators and relate directly to the benefit for the society. Future stock dynamics limits to sustainable ecosystem exploitation and the fishing levels delivering maximum sustainable economic yield under selected climatic scenarios were analyzed in unison to ensure the delivery of mutually consistent management advice. General properties of the ecosystems were used to suggest rules of thumb for management in areas where the amount of data available is insufficient to construct similar models.
The project was coordinated by DTU Aqua.
The project was funded by EU, MariFish, ERA-NET.
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01/01/2009 → 30/06/2012
Keywords: Research areas: Ecosystem based Marine Management & Marine Living Resources & Marine Populations and Ecosystem Dynamics & Population Genetics
Collaborators: Imperial College London, Marine Research Institute Reykjavik, University of Southern Denmark, Wageningen IMARES, Institute of Marine Research, Hellenic Centre for Marine Research, University of Copenhagen, Cefas Weymouth Laboratory, University of St Andrews
Project: Research

Effect of the Horns Rev 1 offshore wind farm on fish communities (38734 and 38735)
The present project focuses on the fish community at the Horns Rev 1 Offshore Wind Farm. The objective of the present study was to document possible refuge effects or changes in local fish communities, seven years after the establishment of the wind farm at a time where wind farm effects on the physical and biological environment could be assumed to have stabilized. Fish communities and sandeel assemblages were compared inside and outside the wind farm area, with the null-hypothesis that the introduction of an offshore wind farm does not affect species composition, temporal or spatial distribution of species or relative abundance.

The project is coordinated by DTU Aqua.
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01/01/2009 → 31/12/2011
Keywords: Research areas: Coastal Ecology & Marine Populations and Ecosystem Dynamics
Collaborators: Orbicon
Project: Research

**Marine fish atlas of Denmark (38852)**
This project will produce an atlas of all the marine fish species found in waters around Denmark. The species occurrence data for the atlas will be based on all types of observational data, such as; fisheries research surveys, commercial fish landings data, recreational fishermen’s landings and diver observations. Users and target audience of the atlas are university and high school students and instructors, scientists, government officials, private companies, NGOs, and the wider Danish public. The atlas will be a reference for scientific outreach product and is a collaboration between DTU Aqua, the Zoological Museum of the Natural History Museum of Denmark and a small private consulting company operated by the former biologist of the Danish Fishermen’s Association. The atlas will contain photographs and maps of the distributional area each species and a short (3-5 page) text describing current knowledge of species’ biology and life history in Danish waters.

The project is coordinated by DTU Aqua.

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01/01/2009 → 31/12/2013
Keywords: Research area: Marine Populations and Ecosystem Dynamics
Collaborators: University of Copenhagen, Krog Consult ApS
Project: Research

**Reproduction of European eel in aquaculture: Consolidation and new production methods (REEL) (38398)**
Project aim: Enhance methods and technology applied to produce and culture European eel larvae as basis for the development of a future self-sustained eel aquaculture.
Background: The severe decline of the European eel stock calls for conservation measures including national eel management plans and establishment of a self-sustained eel aquaculture. In 2005, DTU Aqua, University of Copenhagen and the eel aquaculture industry started to build up a research and technology platform for the development of methods to reproduce European eel in aquaculture.
Two major projects: Artificial Reproduction of Eels II and III (ROE II and III) succeeded during 2005-2008 to produce viable eggs and larvae that lived up to 12 days. The larvae thereby accomplished the yolk sac stage and became ready to start feeding. The results were in particular promising because they evidenced that methods successfully applied to Japanese eel have a potential for application also to European eel. ROE II and III LC were supported by the Danish Ministry of Food, Agriculture and Fisheries and the Financial Instrument for Fisheries Guidance (FIFG) and RO III by the Danish Food Research Program 2006.
Results: The REEL project has accomplished through three series of experiments to consolidate previous results and extend the longevity of larvae from 12 to 20 days after hatch in first feeding experiments. Methods to induce maturation were further tested, and farmed and wild eel broodstocks and different treatments were compared. In particular, fertilization procedures to produce fertilized eggs and embryos and monitoring techniques were enhanced. The technology needed to culture embryos and larvae was substantially improved. The potential for new hormonal treatments was explored and recombinant eel hormones have been produced. New broodstock diets were developed with focus on the lipid composition essential for development and survival of fish larvae. In addition, the experimental facility established by DTU Aqua at Lyksvad Fishfarm was enhanced by improving the experimental and laboratory facilities. The REEL project has provided the basis for the establishment of an EU research project: Reproduction of European Eel: Towards a Self-sustained Aquaculture (PRO-EEL) (38793) coordinated by DTU Aqua. REEL included the partners DTU Aqua, the Danish Eel Producers Association, Billund Aquaculture, BioMar, Bioneer and Copenhagen University of which four are integrated in PRO-EEL.
The project was coordinated by DTU Aqua.

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Influence of ecological dynamics and climate change on the marine environment in Danish waters (ECODYN) (38136)
The environment in the open Danish waters is controlled by a complex interplay between physical and biological processes, and it is therefore difficult to determine the exact cause of changes in the environment. This is also the situation for hypoxia, which is caused both by nutrients from sources ashore, by ecological dynamics of the waters, and by the flow in Kattegat and the Belts. This project examined the marine environment through three-dimensional numerical models which describe both physical and biological processes. In parallel, laboratory experiments clarified how temperature affects the biological rates at or near the sea floor. This was used to model the response of the ecosystem to the temperature increases which are expected as a result of climate change, and the future consequences for the marine environment were analyzed.

Through model simulations and oxygen measurements from ships and buoys, the biological processes leading to hypoxia were determined with the so far highest resolution in time and space; this contributed significantly to the understanding of the functioning of the ecosystem in this area.

The connection between the state of the marine environment and the abundance of fish was analyzed, focusing on the distribution and spawning regions of cod, in relation to the oxygen conditions in the inner Danish waters and in the Baltic Sea. Thereby, the project provided a description of interconnections between the ecosystem, the water flow, and the effects of a changing climate.

The project was coordinated by Department of Bioscience, Aarhus University, Denmark.

MEECE: 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.
Optimizing the exploitation of fishery resources in Skagerrak (OSKAR) (38720)
The purpose of this project was formulated in 2008 to establish knowledge on the geographical distribution of target species in Skagerrak, which enables the fishermen to plan and execute sustainable fisheries on these species with a minimum of discard and unwanted by-catch of cod, and without drastically reductions or unjustified closure of areas. OSKAR was a collaborative fishermen-scientist project building on the experience from the REX-project conducting small-scale scientific surveys with commercial ships.

To separate control issues of the mixed fishery of Skagerrak from the issues of using fishermen's and scientists' combined knowledge and experience to produce more selective fisheries, some of the key questions addressed were:
- Is it feasible to predict the size distribution of cod on a small spatial scale (single trawl haul) from surveys?
- How important are the seasonal changes for the spatial distribution of cod in Skagerrak?
- Can fishermen's anecdotic knowledge on the distribution of cod be used?
- Which role does mechanistic process knowledge play in determining critical spatial dynamics of cod?
- Taking also gear technology into account then how can we best produce e.g. a useful cod avoidance tool?

A new advanced geostatistical tool GeoPop was introduced in order to use all available survey data in the maximum likelihood estimation of temporal and spatial dynamics of the size distribution of the stock. Real time closures, future disallowance of discards etc. put the perspective of OSKAR into focus.

The development of GeoPop in this fishermen-scientist project has proven valuable (see Jansen et al 2016, Fish. Res. 179: 156-167 and refs herein). The method was published in 2013 (Kristensen et al 2013, Can. J. Fish. Aquat. Sci. 99: 1-19). Particular attention in GeoPop is paid to correlation between size classes within each trawl haul due to clustering of individuals with similar size. Extracting this nugget effect produces clearer population signals and allows e.g. following cohorts in space and time and determining stock structures. Although GeoPop today is fully TMB operated it is the present computer capacity which sets the limits to exploring e.g. the impacts of spatial heterogeneity on fishery stock assessment.

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).

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01/01/2008 → 31/12/2011
Keywords: Research areas: Marine Living Resources & Marine Populations and Ecosystem Dynamics & Fisheries Management
Collaborators: Danish Fishermen's Association
Project: Research

Artificial reproduction of eels: Phase III (ROE III) (38187)
The steady decline of the European eel stock has adverse consequences for the Danish eel aquaculture as all eel farming is at present capture based relying on wild caught glass eels. In 2005, DTU Aqua, University of Copenhagen and the eel aquaculture industry started to build up a research and technology platform for the development of methods to reproduce European eel in aquaculture.

The focus of ROE III was to follow up the pioneering work on artificial reproduction of European eels performed in the preceding pilot projects ROE I and II. The projects ROE II and III were a collaboration among DTU Aqua, University of Copenhagen and the eel aquaculture industry following up an initial survey ROE I of suited methodology lead by University of Copenhagen.

ROE III comprised the following activities:
(i) Experimental series with different treatment schemes and hormone dosage to improve the maturation process and optimize gamete quality;
(ii) Development of methods to monitor the maturation process on individual level using ultrasound scanning technology and ovary biopsy;
(iii) Analysis of broodstock fishes and improvement of the dietary fatty acid composition;
(iv) Investigation of parameters determining egg quality during incubation;
(v) First-feeding trials with eel larvae testing both artificial and live feed.
Three experimental series were completed focusing on methods for broodstock enhancement, maturation and fertilization plus culture of eggs and larvae. Already during the first experimental series, larvae accomplishing the entire yolk sac stage were achieved for the first in history for European eel. The yolksac larvae developed successfully during the period were they entirely depend on nutrition sources i.e yolk and lipid of maternal origin. The larvae were ready to start feeding day 12 post hatch. During the second experimental series, larval longevity was extended to 18 days during first feeding experiments. These recent results are a major breakthrough because they show for the first time that artificial hormone treatment can lead to viable offspring in European eel. Eggs and yolksac larvae were obtained from different hormonal treatments and mass hatchings were regularly obtained. Larval feeding using live and artificial larval feeds developed in collaboration with the food company BioMar were developed towards the end of the experiments and are ready for testing in new and coming projects.

The success of this project on improved methods, quality criteria and larval survival has led to form the basis of the project: Reproduction of European eel in aquaculture: Consolidation and new production methods and later (REEEL) (38398) and later the EU FP project: Reproduction of European eel in Aquaculture: Towards a self-sustained aquaculture (PRO-EEL) (38793).

The project was coordinated by DTU Aqua.
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01/01/2007 → 31/12/2009
Keywords: Research areas: Marine Populations and Ecosystem Dynamics & Fish Biology
Collaborators: University of Copenhagen, Bioneer A/S, Billund Aquaculture Service Aps, Danish Eel Farmers Association
Project: Research

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.
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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.

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.
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01/01/2007 → 31/12/2009
Keywords: Research area: Marine Populations and Ecosystem Dynamics
Project: Research

Elucidating the structure and functioning of marine ecosystems through synthesis and comparative analysis (META-OCEANS) (38154)

This project was an EU Marie Curie Early Stage Training PhD network. The project was designed to improve and apply meta-analytical methods to oceanographic and fishery research questions.
There are significant gaps in knowledge regarding the structure of marine food webs, the ecological roles of taxa of different sizes and the factors controlling linkages between different functional groups. Moreover, marine ecosystems continue to suffer from the impacts of human society superimposed on naturally and anthropogenically induced climate variability. These impacts include exploitation, eutrophication, pollution, species transfers and habitat alteration; they cause changes in the structure, function and biodiversity of marine ecosystems. However, the ability of marine scientists to predict the magnitude and direction of how marine taxa, functional groups and entire ecosystems respond to these changes, remains fragmentary. As a result, when asked by society for advice about how marine ecosystems will respond to different kinds of perturbations (including management actions), the marine science community can often only provide answers with high levels of uncertainty.

Students were trained in the use of meta-analysis techniques for marine ecological problems. The statistical methods were comparative and involved regression analysis, time series analysis, Bayesian analysis and trophic modelling. Students attended seminars organized by network scientists and visited scientists in partner institutes to attain additional training. Meta-analyses approaches make use of existing data, produced in the context of different specific analyses, but which gain new value when assembled and re-analysed in a broader perspective. Meta-analyses involve several stages: (1) data mining; (2) quality control, (3) data analysis, and (4) validation. Students were trained in all these steps.
DTU Aqua had two PhD students involved in the project. These projects used Bayesian and meta-analytical methods to show that standardized estimates of maximum population growth rate for all assessed cod stocks vary spatially across the Atlantic and in a dome-shaped relationship with temperature, and that extremely good or bad recruitment occurs in years with extreme temperatures. In addition, new time series-based ways of forecasting cod population dynamics under climate change-exploitation scenarios were developed and the role of a trawling ban on a local cod population was shown to override temperature or other climate effects on stock productivity. Both projects produced papers in high impact journals (2 in Proc. Roy. Soc., 1 in PNAS), as well as in other leading fishery-marine ecology journals (MEPS, ICES, JMS, etc.) s in other leading fishery-marine ecology journals (MEPS, ICES JMS, etc.).
This project was coordinated by AZTI Tecnalia, Spain.
This project was funded by EU, Marie Curie.
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01/03/2006 → 09/12/2011
Keywords: Research areas: Oceanography & Marine Populations and Ecosystem Dynamics
Collaborators: National Center for Scientific Research, CSIC, University of Bergen, AZTI-Tecnalia, Plymouth Marine Laboratory
Project: Research

Danish Network for Aquaculture and Fisheries Research (FISHNET) (38082)
FISHNET is a network of Danish Fisheries and Aquaculture scientists. It was established to foster cooperation in aquaculture and fisheries research and research education in Denmark.
From the start it functioned as an umbrella over four independent thematic research schools and networks in fisheries biology (SLIP), Fisheries and Aquaculture Management and Economics (FAME), Fish Food, Biochemistry and Physiology (FIBP) and Sustainable Control of Fish Diseases in Aquaculture (SCOFDA). In 2001 a research school in Maritime History and Marine Environmental Research (MARINERS) was added to the network.

FISHNET aims to enhance the visibility and quality of Danish fisheries and aquaculture research through improved collaboration and communication, improving the recruitment and training of PhD students through networks and research schools, thus providing high quality courses, seminars and workshops.

FISHNET has organised a large number of joint courses, seminars, workshops and conferences connecting more than 100 fisheries and aquaculture scientists from Danish universities and sectoral research institutions.

In 2004 Fishnet received funds to embed the network through a number of postdoc grants and co-funded professorships in Fisheries Oceanography, Fisheries Management and Fish Physiology.

The merger of the Danish Universities and Sectoral Research Institutions and various changes in Danish marine research made it necessary to extend the second phase of the project from 2008 to the end of 2012.

The project is coordinated by DTU Aqua.
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01/01/2000 → 31/12/2012
Keywords: Research area: Marine Populations and Ecosystem Dynamics
Collaborators: Aarhus University, University of Southern Denmark, University of Copenhagen
Project: Research

Scaling from individuals to populations (SLIP) (38726)
The research school SLIP (Scaling from Individuals to Populations) focuses on how individual behavior and mutual interactions generate the dynamics observed at the population level. This topic forms the link between the basic and applied marine ecological research environments in Denmark and requires input from biology, mathematics and statistics. SLIP is one of the five research networks and research schools under the Danish Network for Aquaculture and Fisheries Research (Fishnet). SLIP has arranged a number of national and international PhD courses and workshops and has served to focus the interest on size and trait-based modeling, as well as on improved understanding of the physiology, genetics and behavior of marine organisms, in particular fish.

The project is coordinated by DTU Aqua.
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01/01/2000 → 31/12/2008
Keywords: Research area: Marine Populations and Ecosystem Dynamics
Collaborators: Aarhus University, University of Copenhagen, Roskilde University
Project: Research